Report on Current Conditions
RCRA Facility Investigation

Chemical Waste Management
Vickery, Ohio

Prepared for:

CWM - Vickery, Inc.
~~December 1994~~ REVISED ~~APRIL 1995~~
June 1995

QUALITY
INTEGRITY
CREATIVITY
RESPONSIVENESS

RUST ENVIRONMENT & INFRASTRUCTURE

Description of Current Conditions
RCRA Facility Investigation
Vickery, Ohio

CWM - Vickery Facility

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Chemical Waste Management, Inc.
Response to Notice of Deficiencies (NODs)
RFI Report on Current Conditions

GENERAL COMMENTS

Comment 1

The term "surface impoundment" was chosen to describe the units throughout the report.

Comment 2

Site specific information has been moved to Section 4.0. Please refer to this section.

Comment 3.

Each of the SWMUs described in Section 5.0 have been modified to include a more precise description of the media of concern as it applies to the potential migration pathways identified. Additionally, Section 5.2 has been modified to include discussions on the groundwater monitoring, which is presently being completed on-site, a brief description of the evolution of the groundwater monitoring system in place at the facility, and a description of the overburden groundwater sampling and analysis program which included the "single sample holes".

Comment 4

The regulatory status section of the forms presented on each of SWMUs in Section 5.0 have been modified to include information such as; if the unit is active or inactive, RCRA or non-RCRA Closed, if it is RCRA Closed approving agency, and the date of closure or inactive status.

Comment 5

Pertinent past facility investigation result summaries have been included within the discussion of the SWMUs where applicable. Additionally, some of the past facility investigation reports which are reference in the text are included as attachments in order to provide more information as needed.

Comment 6

The SWMUs which have documented past releases to surface water have been modified to include surface water as a media of concern. However, since all of the surface impoundments are inactive at the facility the surface water as a migration pathway is no longer a concern. During the implementation of the RFI Work Plan sediments from the surface water bodies surrounding the facility will be investigated.

Comment 7

Soil has been added as a media of concern in each of the SWMUs which have identified releases to the soil have occurred.

Comment 8

The SWMUs and AOCs have been modified to include each of the media of concern(s) which are attributed to them. In each of the SWMUs and AOCs the media(s) of concern are identified if there remains a possibility of migration to that media. If no information is available, the media may still be considered a concern and the migration pathway needs to be evaluated further. This evaluation will be completed as part of the RFI.

Comment 9

Complete sections on the regional deep bedrock system and on the deep well system site bedrock geology has been added in Section's 3.4.1 on page 3-4 and 4.3.1.2 on page 4-3.

SPECIFIC COMMENTS

Comment 1

The correct term " RCRA Facility Investigation" has been corrected throughout the text and figures of the report.

Comment 2

Information on the Surface Water Management Plan and System is provided in Section 2.4 page 2-5.

Comment 3

Information on precipitation/evapotranspiration has been added in Section 3.2 on page 3-1.

Comment 4

Any reference to the site geology has been moved to Section 4.3.1-Site Bedrock Geology. This is the only section which discusses the valley/gully running through the site. Therefore, all contradictory statements have been removed.

Comment 5

Section 3.4.2 has been modified to include a more detailed explanation of the glaciolacustrine/till material at the site. This information, obtained from previous investigation, discusses, in detail the characteristics of the glacial material. This discussion can be found on page 3-7 and 3-8.

Comment 6

Figure 3-3 has been modified to include the legend.

Comment 7

The source has been identified on this figure. However, no data points are available for this figure due to the fact that the figure has been adapted from the document title "Ground-Water Resources of Sandusky County, Ohio" completed as a master thesis by John A. Hoover, University of Toledo, dated December 1982. Figure 3-7 has been obtained from the Bowser-Morner Report titled " Hydrogeologic Assessment, Northern Ohio Treatment Facility" dated May 3, 1983. This figure is only referenced in the text to provide the reader with the general groundwater flow conditions in the carbonate aquifer as being north-northwest toward Lake Erie. This determination comes from the above reference report on the groundwater resources of Sandusky County and is only used to reference documented regional information on the regional groundwater flow direction. Groundwater flow within the bedrock aquifer has also been documented on-site using data from the facility's groundwater monitoring system. Three bedrock potentiometric surface contour maps are provided for review as Figures 4-9, 4-12 and 4-15. Data points are included on these maps.

Comment 8

All references to hydrology and hydrogeological characteristics of the units beneath the facility have been moved to Section 4.4 Hydrogeology.

The text on groundwater flow in the bedrock has been modified to include additional information on the fractured dolomite aquifer and results of aquifer tests conducted by Golder Associates and Bowser-Morner. The results of these tests and a summary of their conclusions is presented on page 4-13 and 4-14.

Comment 9

Figure 4-6 presents the total thickness of the tills at the site. This has been clarified in the text on page 4-9.

Comment 10

A discussion on the K_v of the upper lacustrine material beneath the facility has been moved to the section on Groundwater flow in the Surficial Deposits (Section 4.4.3). A paragraph has been added to Section 4.3.2 which discusses the results of Golder Associates "Continuous Overburden Sampling Results" dated May 1985. This paragraph is included to describe the quantity of work performed during investigations conducted at the site.

Section 4.4.3 has been modified to include a detailed discussion on the groundwater flow in the surficial deposits. This paragraph begins on page 4-14. This paragraph discusses the vertical permeabilities that are used at the site and how they were derived.

Comment 11

Section 4.3.2 page 4-11 discusses the composition of the fill.

Comment 12

Section 4.3.2 page 4-10 discusses the pockets of sand or other granular material found in a few locations across the site during previous investigations. Figure 4-4 has been modified with the control points depicted to indicate that the basil till is not a continuous unit across the site.

Comment 13

The text in Section 4.4.2, page 4-12 has been modified to include a discussion on the bedrock's potentiometric surface.

Comment 14

All references to hydrogeologic characteristics within the glacial material at the site have been moved to Section 4.4.3 - Groundwater Flow in the Surficial Deposits. As indicated in the modified text of this section on page 4-14 through 4-16, references to the how the permeabilities were derived have been provided.

Comment 15

Section 4.4.2- Groundwater Flow in the Bedrock has been modified to include discussions on the characteristics of flow within a fractured dolomite aquifer.

The text in Section 3.5, page 3-8 and 3-9 has been modified to include discussions on the regional groundwater flow and artesian conditions.

Comment 16

The text in Section 3.5, page 3-9 has been modified to discuss information obtained from reference material on the location of areas of discharge for the bedrock aquifer.

Additional figures have been added to the report (Figures 4-12 through 4-17) which present the phreatic surface of the lacustrine unit and potentiometric surfaces of the till and bedrock units for the dates April 11, 1994 and October 18, 1993. These figures are provided to present both seasonal and yearly variations on the groundwater surfaces. Additionally, upon further review and discussions with field personnel responsible for the collection of the water levels, monitoring wells L31 and L33, which present lower water level elevations, have been determined "DRY". This is discussed on Page 4-16 in the text. Additionally, the lacustrine phreatic surface has been re-contoured to indicates this situation.

Comment 17

The text indicates that the lacustrine hydraulic conductivity in the vertical direction as 1×10^{-6} cm/sec and 1×10^{-7} cm/sec in the horizontal direction. As discussed in the text a conservative estimate of 1×10^{-6} cm/se or 1 ft/yr is used for the lacustrine unit to estimate the flow velocities on the map. The hydraulic conductivity of the till unit is estimated at 2×10^{-8} cm/sec or 2×10^{-2} ft./yr. Both of the values are used in the figures presented in the report.

Comment 18

The 100-year travel time presented in the report is an average vertical flow time, calculated by Golder Associates, from lacustrine soils to bedrock.

Comment 19

Figure 4-2 was revised per comment. The legend was modified to include the flow control gates and a note was added to explain the schematic diagram at the top of the figure. Additionally, the area previously shaded purple has been changed to a light gray.

Comment 20

Control points have been added to maps 4-3, 4-4, 4-6 and 4-7.

Comment 21

As explained in the first paragraph of page 4-10, some sand pockets were identified during previous investigation completed at the site. An investigation by Golder Associates in 1985 determined that these sand pockets were isolated and that they did not indicate a continuous grained layers within the till. Additionally, none of the isolated sand pockets are located in the area of the thin till, which coincides with the thick lacustrine deposits.

Comment 22

Section 4.4.2 discusses the Groundwater flow in the bedrock. A paragraph has been added discussing Golder Associates conclusions concerning the potentiometric surface at the southeast boundary of the facility. All dates have been included on each of the figures.

Comment 23

All phreatic and potentiometric maps included with the report have been updated to include exact dates of measurements. Additionally, two additional water level measurement events have been included for comparison of years and seasonal variations, and the arrows depicting flow direction have been differentiated from the gradients.

Comment 24

As described in the second paragraph on page 4-15, the capillary drain has an effect on the surficial deposits phreatic and potentiometric surfaces.

Comment 25

The landfarming of sludges is briefly introduced in the third paragraph of page 2-3.

Comment 26

The report which is referenced is discussed in further detail on page 5-1 in Section 5.1.1-Landfarming of Sludges.

Comment 27

The CAFO is included as Attachment B.

Comment 28

The location of the SWMU is described in further detail in the Unit Description section of the SWMU - 5 form. Soil is not included as a media of concern due to the "Clean Closed" status of the SWMU. Additional information on the closure of this unit can be found in Section 6.2.

Comment 29

Attachment D provides the review of the L19 investigation. This report provides the Golder Associates conclusions on the existence of contamination around this area. Additionally, groundwater flow velocities with the lacustrine, till and bedrock units are discussed is Section 4.0.

Comment 30

As indicated in the text on page 5-55, one soil sample was collected in SWMU 12. The data on these samples are provided in Attachment A. No data can be found on confirmatory soil sampling in each of landfarm areas. However, the RFI Work Plan will propose confirmatory soil sampling in each of these areas..

Comment 31

The section regardin migration pathways on page 5-71 has been modified.

Comment 32

Additional information on SWMU# 20 has been obtained from the facility record and is included in the form. The previously identified steel tank was discovered to be a concrete cistern. This tank was removed in 1983 when discovered during a routine pump-out that a wet spot was observed in the adjacent grass. It was discovered that the concrete cistern was corroded and cracked at the sewer line connection. The cistern and two feet of clayey soil was removed and a new poly-lined concrete vault and polyethylene tank was installed. As described in the text, in 1992 another polyethylene tank was installed and the concrete vault was relined.

Comment 33

The text has been modified to include the reason for soil to be a media of concern.

Comment 34

A discussion has been added to the text to describe that excavation to a certain depth took place in each of the borrow areas. Clay still exists to inhibit the migration of contaminants, if any is present.

Comment 35

The text has been modified to include the surface water as a media of concern.

Comment 36

The Dames & Moore report is included as Attachment E. The text was also modified to include a brief discussion on the conclusions of this report.

Comment 37

The term "Oil Recovery Area" has been used throughout the report and on the figures.

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FIGURE

1.0 INTRODUCTION

1.1 PURPOSE

This document presents a description of current conditions that exist at the CWM - Vickery facility. This includes a facility background, a list of Solid Waste Management Units (SWMUs), Areas of Concern (AOCs), the nature and extent of contamination, and a description of interim corrective measures. The facility background summarizes pertinent information such as; regional location, general physiography, hydrogeology, and operational, regulatory and permit history. The list of SWMUs and AOCs and the nature and extent of contamination will describe any existing information on the nature and extent of releases, including a summary of all possible source areas of contamination. Also, this document describes interim corrective measures that were or are being undertaken at the facility. This document is being completed as a result of the recent issuance of the CWM - Vickery facility RCRA Part B Permit. As a condition to this permit, a RCRA ~~Feasibility~~ FACILITY Investigation (RFI) must be performed. As a prescusor to the drafting of an RFI - Work Plan, a description of current conditions must be submitted to the United States Environmental Protection Agency (USEPA) presenting conditions which currently exist at the facility. This document updates conditions on-site since the RCRA Facility Assessment (RFA) Report, dated March 1991 was completed by Jacobs Engineering as a subcontractor to Metcalf & Eddy. Information from the RFA Report is used in this document for comparison to current conditions. A description of this information and where it is located within this document is presented in the following paragraphs.

~~It should be noted that for the purposes of this document the terms Pond, Impoundment and Surface Impoundment are interchangeable. Additionally, the term closure or closed is not to be misinterpreted as the regulatory term of the same name and merely implies that a unit is out of service or inactive.~~

Section 2.0 through 4.0 presents the facility background for the CWM - Vickery facility. Section 2.0 summarizes the site location, the operational and regulatory history of the facility, PROCESS and permit information. Section 3.0 includes the background information on the regional setting, including, topography, climate, surface water, geology and hydrogeology. Section 4.0 of the document presents site specific background information on the facility's physiography including: topography, surface water, geology, and hydrogeology.

Section 5.0 presents information and conclusions on the SWMUs and AOCs including information from previous investigations performed at the facility. Section 6.0 described interim corrective measures that have been completed or which are in the process of being completed at the facility. These interim corrective measures includes closures that have been completed at the facility since the 1991 RFA Report. A list of references follows the document in Section 7.0.

FIGURES

2.0 BACKGROUND

2.1 SITE LOCATION

The CWM - Vickery Facility is located in a rural, unincorporated area of Sandusky County in the north-central part of Ohio. The facility encompasses 98 acres and is located adjacent to State Route 412 near the intersection of State Route 510 and 412. The facility is bounded by highways 412 and 510 on the south and east, by the Ohio Turnpike on the north and Meyers Ditch on the west, although an additional portion of the facility property extends further west to County Road 244. The geographic coordinates of the facility are north latitude 41° 22' 19" and west longitude 82° 22' 40". The facility is located in a rural area, and is surrounded by active farms. The unincorporated community of Vickery lies 2 miles northeast of the site, and the cities of Clyde and Fremont are located approximately 4 miles to the south and 6 miles to the west, respectively. Figure 2-1 presents the location of the CWM - Vickery, Ohio facility.

2.2 OPERATIONAL AND REGULATORY HISTORY

The CWM - Vickery facility provides for the treatment, storage and disposal of liquid hazardous waste. Operations at this facility began in 1958 under the name of Don's Oil Service. The site later changed its name to Ohio Liquid Disposal (OLD) in 1970. WMI acquired the site in June, 1978 and later transferred it to Chemical Waste Management.

Don's Oil Service was organized to provide a service to various industries by gathering waste oils, hauling these oils to a central facility and recovering these oils for eventual resale. SOME OF THE OILS ACCEPTED AT THE FACILITY INADVERTENTLY INCLUDED PCB CONTAINING OILS. IN 1961 THE OPERATION WAS EXPANDED AND A SMALL QUANTITY OF LIQUID INDUSTRIAL WASTES WERE HAULED TO THE FACILITY. THESE LIQUID INDUSTRIAL WASTES WERE HELD IN SMALL PONDS ALONG WITH OILY WASTES. IN 1964 THE FIRST SURFACE IMPOUNDMENT WAS CONSTRUCTED TO SPECIFICALLY IMPOUND THE WASTES WHICH WERE SEPARATED FROM THE OILS. ~~In 1961, the company began to accept various industrial wastes, such as cutting oils, hydraulic fluids, and some solvents.~~ These materials were stored in surface impoundments. In 1964, the Ohio Water Pollution Control Board (predecessor to the Ohio Environmental Protection Agency) granted the facility permission to accept chemical process wastes such as pickle liquors from metal-working operations, lime sludge, and other miscellaneous chemical products. More ~~ponds~~

SURFACE IMPOUNDMENTS were constructed to facilitate the growing inventory of liquid wastes, and by the late 1960's, the amount of industrial wastes received by the facility exceeded that of waste oil.

In 1971, the firm was incorporated as Ohio Liquid Disposal, Inc. Faced with growing volumes of waste, the company began investigating a suitable means of disposal. In 1972, permission was granted by the Ohio Division of Oil and Gas to drill a test hole to evaluate subsurface conditions for a possible injection well. An application was submitted for permission to use this well for injection of industrial waste. In September 1972, the Water Pollution Control Board refused to grant the company a permit. In this same month, the Division of Oil and Gas refused to issue the permit to convert the well for waste disposal. These decisions were appealed through the state judicial system, and in May of 1975, the State Court of Appeals in Toledo, Ohio, ruled that the permit must be issued. In July of 1975, a permit to use well No. 1 as a waste disposal well was issued by the Division of Oil and Gas. Injection into this well began in June 1976. In January 1976, permits were issued for the installation of wells Nos. 2, 3, and 4. Well No. 2 was completed in November 1976 and injection began in March 1977. Injection Wells 3 and 4 were both completed in November 1976, with injection beginning in August 1977. In 1978, Ohio Liquid Disposal was purchased by Chemical Waste Management (CWM).

During the history of the site a total of 12 surface impoundments existed. These surface impoundments were numbered in consecutive order from 1 through 12, with the exception of Surface Impoundment 8, which was combined with 7.

In 1964, Don's Oil Service constructed the first ~~pond~~ SURFACE IMPOUNDMENT for the storage of liquids. Although the ~~ponds~~ SURFACE IMPOUNDMENTS were not numbered at that time, this presumably was ~~pond~~ SURFACE IMPOUNDMENT 1. In 1966 Don's Oil Service proposed to the State of Ohio to construct two more ~~ponds~~ SURFACE IMPOUNDMENTS. These ~~ponds~~ SURFACE IMPOUNDMENTS (presumably ~~ponds~~ SURFACE IMPOUNDMENTS 2 and 3) were constructed and placed in operation some time between 1967 and 1970. Shortly after Don's Oil Service incorporated itself as OLD, an application was filed with the State of Ohio Department of Health to construct ~~ponds~~ SURFACE IMPOUNDMENTS 6, 7 and 9. A similar application was filed in 1972 for the construction of ~~pond~~ SURFACE IMPOUNDMENT 10. Although there is conflicting documentation, ~~ponds~~ SURFACE IMPOUNDMENTS 4, 5 and 7 were apparently constructed in 1972 and ~~ponds~~ SURFACE IMPOUNDMENTS 6 and 10 were constructed sometime between 1972 and 1973. ~~ponds~~ SURFACE IMPOUNDMENTS 11 and 12 are believed to have been constructed between 1973 and 1975.

In 1979, due to corrosion of the long string casing in well No. 1, injection was halted and the well was eventually plugged and capped. To replace well No. 1, well No. 1A was drilled and completed in October 1979. Injection into this well began in January 1980. As injection of wastes was continuing, closures of the surface impoundments was initiated. ~~ponds~~ SURFACE IMPOUNDMENTS 2, 3 and 6 east were closed in 1979. ~~pond~~ SURFACE IMPOUNDMENT 1 was closed in 1980. ~~ponds~~ SURFACE IMPOUNDMENTS 6 west and 9 were closed in 1981. Wells No. 5 and 6 were completed in December 1980 and May 1981, respectively. Injection of waste into both of these wells began in September 1981. In 1982 ~~pond~~ SURFACE IMPOUNDMENT 10 was closed and in 1985 ~~ponds~~ SURFACE IMPOUNDMENTS 4, 5 and 7 were closed. Finally, ~~ponds~~ SURFACE IMPOUNDMENTS 11 and 12 were closed in 1992. Details on closure of these facilities are presented in Section 6.0

The methods and documentation of closure of the ~~ponds~~ SURFACE IMPOUNDMENTS described above varied widely depending on the timeframe and included transferring liquids, removing sludges, and backfilling with either clean soil or clay, and in some cases construction debris. Records of the soil sampling completed during these closures indicate that some sludges may not have been fully removed and that residual contamination may exist. Some specifics are explained in the Corrective Action Strategy Report completed by ICF Technology in 1987.

Additionally, a number of facilities have been used at the site to treat, store and dispose of the wastes. THE landfarming OF SLUDGES took place during the years 1975 through 1984 and an Oil Reclamation Facility was active between 1967 and 1985. The W-Tanks, which held wastes prior to deep well injection, were certified clean closed with excavated soils being sent for off-site disposal in 1992.

In 1984 and 1985 all on-site injection wells were reworked and repaired. In May of 1986 well No. 3 was also found to have corrosion problems and operation of that well ceased at that time. It was plugged in July of 1987. Well 1A was also taken out of service in the fall of 1987 for the same problem, which left the facility with four operating injection wells which are presently active.

The closure cell was built between 1986-1988 and again in 1990 the waste pile was moved into the closure cell. Soils from underneath the closure cell were excavated AND PLACED INTO

THE TEMPORARY WASTE PILE. SAMPLES OF THESE SOILS WERE COLLECTED TO CONFIRM REMOVAL OF ALL POTENTIAL CONTAMINATION. SURFACE IMPOUNDMENT 4, 5 AND 7 WERE APPROVED BY THE OEPA AS CLEAN CLOSED. RESULTS FOR CLOSURE WERE PROVIDED TO THE OEPA AND USEPA. Contingent closure was achieved in the area of the waste pile and clean closure was achieved for the waste piles former leachate retention basin. Approximately 2 feet of clay from Borrow Pit 2 was placed in this area and the entire area was graded to promote surface run-off from the closure cell. ~~ponds~~ SURFACE IMPOUNDMENTS 11 and 12 were clean closed in 1992 as excavated soils were placed in the closure cell and the area was graded to promote surface runoff. The existing facility is presented in Figure 2-2.

Presently, CWM receives a large variety of liquid hazardous wastes. The most common waste types include; pickle liquors, acid wastes, caustic wastes, neutral waters, and other aqueous wastes. The facility does not accept radioactive wastes, infectious wastes, explosive or shock sensitive wastes, air reactive wastes, water reactive wastes, compressed gases, reactive wastes that generate dangerous quantities of toxic or explosive gases when acidified, bulk ignitable wastes, bulk wastes containing >5% VOCs, or wastes that the facility deems can not be managed properly. A complete list of acceptable wastes codes are provided in Table 2-1.

2.3 PROCESS INFORMATION

All hazardous wastes received at the facility are delivered by truck. The waste is offloaded at the truck unloading and washing facility. The waste then flows to and through one of four grit filters and into one of four waste receiving tanks (V-Tanks) or is pumped directly to a T-Tank. The wastes, if gravity unloaded, are then pumped from the V-Tanks to the T-Tanks. The wastes which are stored in the T-Tanks are pumped through leaf filters and/or a filter press unit to remove suspended particles. The wastes are then blended for injection in the T-Tanks. The blending process ensures a relatively constant pH and chemical profile of the wastes which are injected.

After the blending is completed, the aqueous wastes are pumped to Filtered Acid Tanks (FATs) located near the four active injection wells. The FATs are used as surge tanks so that the liquids can be injected into the wells at a constant pressure or constant flow. The wastes are passed through a final polish filter of 5 microns in the pump house to remove any fine particles before being pumped under pressure to deep well injection.

2.4 PERMITS

CWM filed a "Notice of Hazardous Waste Activity" on August 18, 1980 identifying itself as a TSD facility. Their Resource Conservation and Recovery Act (RCRA) Part A Permit application was first submitted on November 19, 1980. The Part A Permit application has subsequently undergone numerous changes. The Part B Permit was originally submitted in 1985 and the Final Part B Permit was issued on October 24, 1994.

CWM operates under a number of permits issued by both federal and state agencies. The following permits are utilized by the facility:

Permit Classification
National Pollution Discharge Elimination System (NPDES)
Toxic Substances Control Act (TSCA)
Underground Injection Control (UIC)
Resource Conservation and Recovery Act (RCRA)
Public Utilities Commission (PUCO)
Clean Air Act (CAA)

The CWM Vickery holds a TSCA approval for the waste in the closure cell as well as a UIC federal program no migration petition approval for the injection wells. The CWM facility has determined that the following federal laws do not apply to their operation: The Wild and Scenic Rivers Act, The National Historic Preservation Act of 1966, The Endangered Species Act, The Coastal Zone Management Act, or the Fish and Wildlife Coordination Act.

A series of Ohio EPA permits govern discharges and emissions to the environment. The Ohio Hazardous Waste Facility Approval Board has issued a Hazardous Waste Permits-to-Install and Operate. The revision and renewal of this report has been administered by the OEPA. The facility operates an NPDES Permit to discharge stormwater and treated sanitary sewage to Meyers Ditch. Currently sanitary sewage discharge is not done due to the high chlorine content of the effluent. The sanitary effluent is stored in a tanker truck and transferred to the aqueous treatment facility for disposal by deep well injection.

Additional state permits issued to the facility include a Permit-to-Install for the Surface Water Management System and Air Permits-to-Install and Air Permits-to-Operate for emission sources at the facility.

A SURFACE WATER MANAGEMENT PLAN (SWMP), DATED NOVEMBER 8, 1983, WAS AUTHORIZED UNDER A PERMIT TO INSTALL (PTI) FROM THE OEPA, NO. 03-1567, EFFECTIVE NOVEMBER 22, 1983. THIS PLAN PROVIDES FOR AN INTEGRATED SYSTEM TO CONTROL SURFACE WATER RUNON AND RUNOFF FROM THE FACILITY. THE SURFACE WATER MANAGEMENT SYSTEM, AS DESCRIBED IN THE SWMP, IS PERMITTED UNDER THE FACILITIES NATIONAL POLLUTANT ELIMINATION SYSTEM (NPDES) PERMIT NO. 2IN00016*ED.

THE OBJECTIVE OF THE SWMP AT THE CWM VICKERY FACILITY IS TO CONTROL THE SURFACE WATER RUNON AND RUNOFF IN ORDER TO MINIMIZE THE VOLUME OF WATER POTENTIALLY EXPOSED TO HAZARDOUS WASTES. THIS, IN TURN, MINIMIZES THE VOLUME OF WATER WHICH MUST BE TREATED. THIS IS ACCOMPLISHED USING GRADING AND CHANNELLING TO EXPEDITE RUNOFF MOVEMENT TO EMBANKMENTS AND FLOW CONTROL GATES WHICH PROVIDE CONTAINMENT OF FLUIDS WITHIN DISCRETE AREAS OF THE SITE.

THE SITE RUNOFF IS SAMPLED AND BASED ON THE RESULTS, EITHER REMOVED FOR APPROPRIATE DISPOSAL OR ALLOWED TO DISCHARGE FROM THE SITE AT SELECTED LOCATIONS. THESE CONTAINMENT AREAS ARE SHOWN IN COLOR ON FIGURE 4-2. AS ILLUSTRATED BY THE SCHEMATIC DIAGRAM AT THE TOP OF FIGURE 4-2, THE FLOW CONTROL GATE SYSTEM CAN BE USED TO CONTROL THE FLOW OF WATER OFFSITE.

TABLES

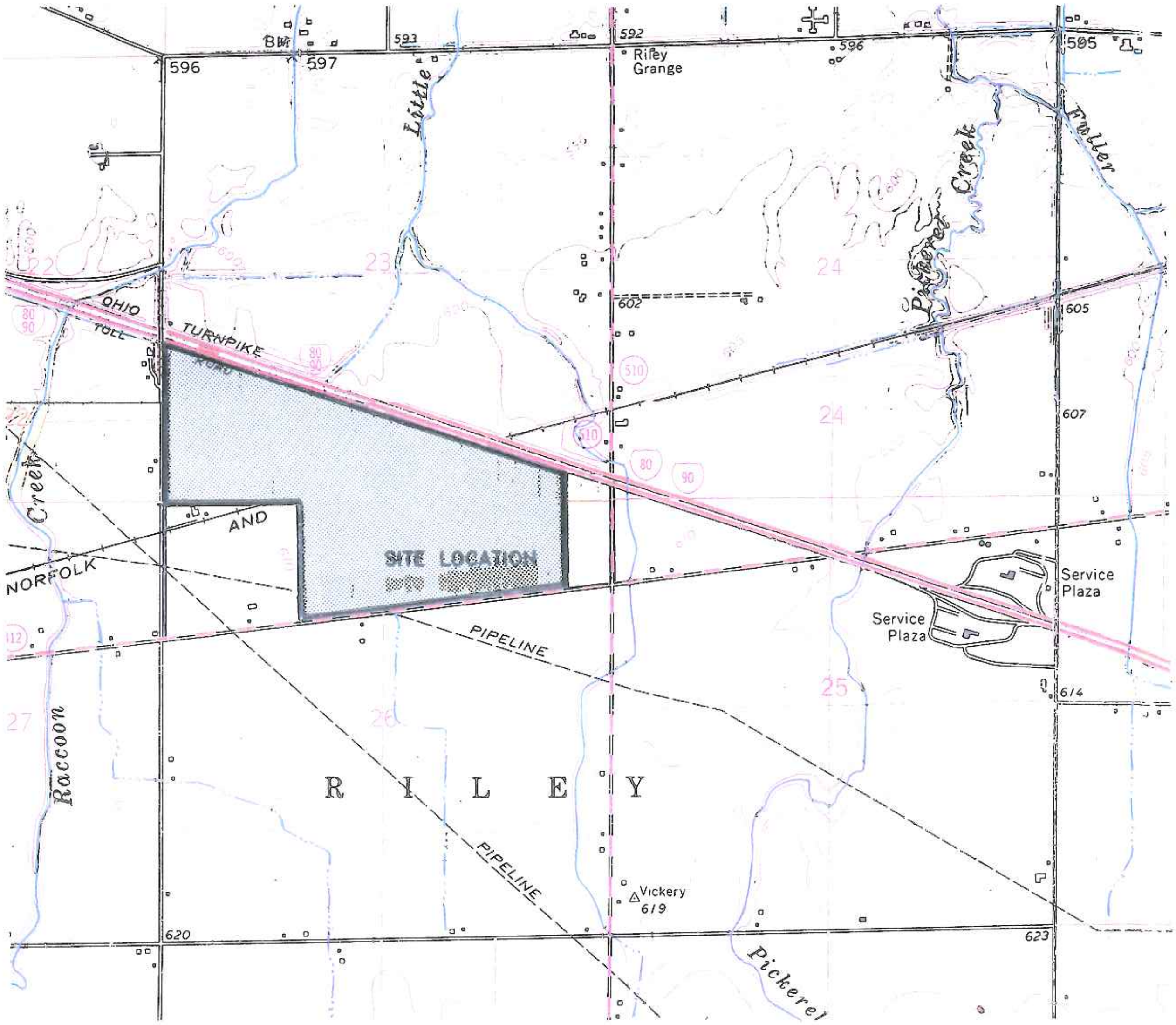
TABLE 2-1
LIST OF ACCEPTABLE WASTE CODES
CWM, VICKERY FACILITY

D001	D043	K001	K043	K106	P001	P046	P097	U001	U044
D002	F001	K002	K044	K107	P002	P047	P098	U002	U045
D003	F002	K003	K046	K108	P003	P048	P099	U003	U046
D004	F003	K004	K046	K109	P004	P049	P101	U004	U047
D005	F004	K005	K047	K110	P005	P050	P102	U005	U048
D006	F005	K006	K048	K111	P006	P051	P103	U006	U049
D007	F006	K007	K049	K112	P007	P054	P104	U007	U050
D008	F007	K008	K050	K113	P008	P056	P105	U008	U051
D009	F008	K009	K051	K114	P009	P057	P106	U009	U052
D010	F009	K010	K052	K115	P010	P058	P107	U010	U053
D011	F010	K011	K060	K116	P011	P059	P108	U011	U055
D012	F011	K013	K061	K117	P012	P060	P109	U012	U056
D013	F012	K014	K062	K118	P013	P062	P110	U014	U057
D014	F019	K015	K064	K123	P014	P063	P111	U015	U058
D015	F032	K016	K065	K124	P015	P064	P112	U016	U059
D016	F034	K017	K066	K125	P016	P065	P113	U017	U060
D017	F035	K018	K069	K126	P017	P066	P114	U018	U061
D018	F037	K019	K071	K131	P018	P067	P115	U019	U062
D019	F038	K020	K073	K132	P020	P068	P116	U020	U063
D020	F039	K021	K083	K136	P021	P069	P118	U021	U064
D021		K022	K084	K141	P022	P070	P119	U022	U066
D022		K023	K085	K142	P023	P071	P120	U023	U067
D023		K024	K086	K143	P024	P072	P121	U024	U068
D024		K025	K087	K144	P026	P073	P122	U025	U069
D025		K026	K088	K145	P027	P074	P123	U026	U070
D026		K027.	K090	K147	P028	P075		U027	U071
D027		K028	K091	K148	P029	P076		U028	U072
D028		K029	K092	K149	P030	P077		U029	U073
D029		K030	K093	K150	P031	P078		U030	U074
D030		K031	K094	K151	P033	P081		U031	U075
D031		K032	K095		P034	P082		U032	U076
D032		K033	K096		P036	P084		U033	U077
D033		K034	K097		P037	P085		U034	U078
D034		K035	K098		P038	P087		U035	U079
D036		K036	K099		P039	P088		U036	U080
D037		K037	K100		P040	P089		U037	U081
D038		K038	K101		P041	P092		U038	U082
D039		K039	K102		P042	P093		U039	U083
D040		K040	K103		P043	P094		U041	U084
D041		K041	K104		P044	P095		U042	U085
D042		K042	K105		P045	P096		U043	U086

TABLE 2-1
LIST OF ACCEPTABLE WASTE CODES
CWM, VICKERY FACILITY

U087	U103	U119	U134	U150	U165	U181	U197	U215	U235
U088	U105	U120	U135	U151	U166	U182	U200	U216	U236
U089	U106	U121	U136	U152	U167	U183	U201	U217	U237
U090	U107	U122	U137	U153	U168	U184	U202	U218	U238
U091	U108	U123	U138	U154	U169	U185	U203	U219	U239
U092	U109	U124	U140	U155	U170	U186	U204	U220	U240
U093	U110	U125	U141	U156	U171	U187	U205	U221	U243
U094	U111	U126	U142	U157	U172	U188	U206	U222	U244
U095	U112	U127	U143	U158	U173	U189	U207	U223	U246
U096	U113	U128	U144	U159	U174	U190	U208	U224	U247
U097	U114	U129	U145	U160	U176	U191	U209	U225	U248
U098	U115	U130	U146	U161	U177	U192	U210	U226	U249
U099	U116	U131	U147	U162	U178	U193	U211	U227	U328
U101	U117	U132	U148	U163	U179	U194	U213	U228	U353
U102	U118	U133	U149	U164	U180	U196	U214	U234	U359

FIGURES



SCALE 1:24 000

1 — ½ — 0 — 1 MILE

1000 — 0 — 1000 — 2000 — 3000 — 4000 — 5000 — 6000 — 7000 FEET

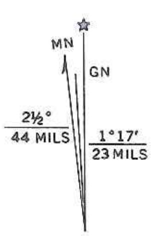
1 — 5 — 0 — 1 KILOMETER

CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL

CLYDE, OHIO
SW/4 BELLEVUE 15' QUADRANGLE
N4115—W8252.5/7.5

1969

QUADRANGLE LOCATION



UTM GRID AND 1969 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

RUST ENVIRONMENT & INFRASTRUCTURE

SIGNATURE

DATE

REV.	DATE	DESCRIPTION	DRN BY	APP BY

DATE: DECEMBER, 1994

PROJECT NO. 38627 | SCALE: AS SHOWN

DES BY
DRN BY JAT
CHK BY RZ
REV BY
APP BY

PROJECT: RCRA FACILITY INVESTIGATION

SHEET TITLE: SITE LOCATION PLAN

CWM-Vickery
Vickery, Ohio

SHEET ____ OF ____

DRAWING NO.

FIGURE 2-1

3.0 REGIONAL PHYSIOGRAPHY/GEOLOGY

3.1 TOPOGRAPHY

The regional topography is very flat with a gentle slope to the north towards Sandusky Bay. The flatness is broken only by steep-walled streams which flow almost directly north towards Sandusky Bay. All of the streams in the area tend to run parallel to each other for some distance before converging.

3.2 CLIMATE

The climate of the site and of Sandusky County is classified as continental. The area has large annual and daily ranges of temperature. Summers are warm and humid with several days having temperatures exceeding 89°F. Winters are cold and cloudy with occasional sub-zero temperatures. The mean annual temperature is approximately 50°F. The warmest month of the year is usually July, with an average temperature of approximately 74°F. The coldest month of the year is usually January, with an average temperature of approximately 25°F.

Precipitation in the area varies widely from year-to-year; however, it is normally abundant and well-distributed throughout the year with winter being the driest season. The mean annual precipitation is approximately 33 inches and the mean average snowfall is approximately 31 inches. On the average, there are five days per year with one inch or more of precipitation.

EVAPOTRANSPIRATION WILL GENERALLY EXCEED THE NORMAL RAINFALL IN THE MONTHS OF MAY THROUGH SEPTEMBER. WHEN EVAPOTRANSPIRATION GREATLY EXCEEDS PRECIPITATION FOR AN EXTENDED PERIOD OF TIME, A DROUGHT MAY OCCUR. THE LONGEST CONTINUOUS DROUGHT ON RECORD IN NORTH CENTRAL OHIO IS 35 MONTHS FROM NOVEMBER 1962 TO SEPTEMBER 1965 (U.S. DEPT. OF COMMERCE, 1974).

PRECIPITATION IS GREATEST IN THE REGION DURING THE MONTHS BETWEEN MARCH THROUGH JULY. DURING SPRING, AS VEGETATION BECOMES MORE ABUNDANT AND THE TEMPERATURE INCREASES, EVAPOTRANSPIRATION OFTEN EXCEEDS PRECIPITATION WHICH RESULTS IN A SOIL MOISTURE DEFICIENCY.

ANY SUBSEQUENT PRECIPITATION INFILTRATES INTO THE SOIL AND REDUCES THE AMOUNT OF SURFACE RUNOFF.

PRECIPITATION DECLINES FROM AUGUST THROUGH OCTOBER AT WHICH TIME EVAPOTRANSPIRATION EXCEEDS THE SOIL MOISTURE REPLENISHMENT OVER AN EXTENDED PERIOD OF TIME. AS AUTUMN PROCEEDS AND VEGETATION SLOWLY RECEDES, THE RATE OF EVAPOTRANSPIRATION DECREASES AND THE SOIL MOISTURE IS TYPICALLY REPLENISHED. THE PRECIPITATION/ EVAPO-TRANSPIRATION RATIO WAS CALCULATED BASED ON AVERAGE TEMPERATURE AND PRECIPITATION FROM THE YEARS 1993 AND 1994. THE RATIO WAS CALCULATED TO BE 56.89.

3.3 SURFACE WATER HYDROLOGY

Regional surface water bodies in the area of the facility are Sandusky Bay and the Sandusky River. The Vickery facility is located within the Lake Erie drainage basin. Local surface water features include Raccoon and Little Raccoon Creeks. Little Raccoon Creek lies about 250 feet east of the eastern facility boundary. Raccoon Creek lies approximately one-quarter mile west of the western facility boundary. Little Raccoon Creek is a small perennial stream that is subject to highly seasonal flow; the United States Geological Survey (USGS) topographic map indicates the stream becomes an intermittent stream approximately one-quarter mile upstream from the southeast corner of the facility. Raccoon Creek is a large perennial stream that originates in Seneca County, south of Clyde. Clyde uses Raccoon Creek for water supply and also discharges the final effluent from their waste water treatment plant to Raccoon Creek. Figure 3-1 presents the regional drainage patterns for northwestern Ohio.

One spring is known to flow into Raccoon Creek. This spring, known locally as "Poorman's Spring" is located in Riley Township. The spring is noted for its very high content of sulfate. In addition, the Meyers Ditch, which bisects the facility, ultimately flows into Little Raccoon Creek.

Sandusky County has been evaluated by the U.S. Department of Housing and Urban Development for flood insurance. The 100-year flood boundaries that were determined are presented in Figure 3-2. As indicated, facility is not located within the 100-year flood plain on any surface waters features.

3.4 GEOLOGY AND SOILS

3.4.1 Bedrock Geology

The facility is located on the east flank of the Findlay Arch which separates the Michigan and Appalachian basins. The bedrock in the area of the facility dips gently to the east, towards the center of the Appalachian basin. Older rocks are found to the west and northwest on top of the Findlay Arch while younger rocks are found to the east towards the center of the basin (Figure 3-3).

The Findlay Arch often acted as a barrier to flow between the bodies of water on either side due to it being topographically higher than the basins on either side. At various times, depending on the regional tectonic activity, the arch was either covered by shallow seas or was exposed to the air.

The bedrock located under the facility consists of dolomites of the Salina Group. This dolomite is generally described as thin-bedded, gray-brown, very fine-grained dolomite, with numerous argillaceous zones and evaporite (gypsum and anhydride) beds. The dolomite is generally well parted with many of the partings containing secondary fillings of gypsum and occasionally calcite (Janssens 23-25). Dolomites of the Salina Group have been cored at the facility to depths of 125 feet below ground surface. These cores contained frequent highly weathered zones and some small (typically less than one inch) solution cavities and voids. Gypsum was also often noted as a coating on the open fractures and cavities. The formations of the Salina Group constitute the uppermost bedrock aquifer underlying the Vickery facility (Breen et. al 32-37). Figure 3-4 presents the stratigraphic column of Silurian Rocks of Northwestern Ohio.

~~The top of bedrock contours for the facility have been estimated from boreholes.~~ THE BEDROCK SURFACE IS MARKED BY A MAJOR VALLEY TRENDING NORTH/SOUTH THROUGH THE CENTER OF RILEY TOWNSHIP. The REGIONAL bedrock topography FOR THE COUNTIES SURROUNDING THE CWM-VICKERY FACILITY is presented as Figure 3-5. ALTHOUGH THIS BURIED VALLEY AND THE MODERN SANDUSKY RIVER PARALLEL, THEIR VALLEYS ARE UNRELATED TO EACH OTHER. THE EASTERN SIDE OF THE BURIED VALLEY, OVER WHICH THE CWM-VICKERY FACILITY IS LOCATED, IS RELATIVELY STEEPER THAN THE WESTERN SIDE OF THE VALLEY.

THE SLOPE, HOWEVER, APPEARS TO BE UNIFORM WITHOUT ANY MAJOR FEEDER VALLEYS. ~~This interpretation shows a general ridge section running southwest to northeast, across the southern third of the facility and a general flat wide area underlying the active facility area.~~

THE DEEP BEDROCK GEOLOGY IN THE SURROUNDING REGION CONSISTS OF AN ERODED PRECAMBRIAN BASEMENT ROCK OVERLAIN BY SEVERAL THOUSAND FEET OF PALEOZOIC SEDIMENTARY ROCK, DERIVED PRIMARILY FROM MARINE AND NEARSHORE ENVIRONMENTS. THE BASEMENT GEOLOGY, AS INTERPRETED FROM LIMITED DEEP BORINGS (LUCIUS, 1985) AND EXTRAPOLATION FROM OUTCROPS IN CANADA (DAVIDSON, 1986; RIVERS et al., 1989) IS DIVIDED INTO TWO MAJOR LITHOLOGIC PROVINCES. THE GRENVILLE PROVINCE, EAST OF THE SITE, IS COMPRISED OF HIGH-GRADE METAMORPHOSED SEDIMENTARY AND VOLCANIC ROCKS. WEST OF THE SITE, THE GRENVILLE FRONT FORMS THE WESTERN MARGIN OF A TRANSITIONAL BOUNDARY ZONE WITH INTRUSIVE AND EXTRUSIVE IGNEOUS AND LOW-GRADE METAMORPHIC ROCKS OF THE CENTRAL PROVINCE IN WESTERN OHIO. THE GRENVILLE FRONT IS APPARENTLY A LOW ANGLE, EASTERLY DIPPING THRUST FAULT ZONE, THAT ORIGINATED DURING LATE PRECAMBRIAN CONTINENTAL COLLISION AND ACCRETION OF THE GRENVILLE PROVINCE TO THE CENTRAL PROVINCE CRATON (GREEN et al., 1988; PRATT et al., 1989).

AFTER A SUBSTANTIAL, LENGTHY EROSIONAL EPISODE REDUCED THE PRECAMBRIAN BASEMENT SURFACE TO A LOW-RELIEF PENEPLAIN, A SERIES OF SHALLOW MARINE INCURSIONS INITIATED DEPOSITION OF CAMBRO-ORDOVICIAN SEDIMENTS. THESE RELATIVELY UNDEFORMED SEDIMENTS FORM THE PALEOZOIC STRATIGRAPHY WHICH IS 2900 FEET THICK IN THE REGION.

THE STRATIGRAPHIC SEQUENCE INCLUDES SANDSTONES, DOLOMITES, SANDY DOLOMITES, LIMESTONES AND SHALES, WITH INTERSPERSED EROSIONAL INTERVALS, AND HAS BEEN CORRELATED WITH VARIATIONS IN SEA LEVEL AND CRUSTAL UPLIFT AND SUBSIDENCE, CAUSED BY EARLY EPEIROGENIC EVENTS WITH THE CRATON AND LATER OROGENIC EVENTS ORIGINATING FAR TO THE SOUTHEAST. INITIALLY, REGIONAL EPEIROGENIC SUBSIDENCE OF THE DEEPLY ERODED PRECAMBRIAN BASEMENT SURFACE, PRODUCED WIDESPREAD

SEDIMENTARY DEPOSITION OF THE MT. SIMON FORMATION IN A SHALLOW EPEIRIC MARINE ENVIRONMENT BENEATH THE SITE AND SURROUNDING REGION. DEEPER WATER MARINE SEDIMENTS WERE DEPOSITED, TO THE SOUTHEAST, ON A COASTAL MARGIN AND A SHELF DEVELOPED ON AN EXTENDING AND SUBSIDING CONTINENTAL CRUST.

CONTINUED GRADUAL SUBSIDENCE AND MARINE TRANSGRESSION ON THE PASSIVE COASTAL MARGIN CREATED SLIGHTLY DEEPER MARINE CONDITIONS IN WHICH NEARSHORE CARBONATES OF THE ROME AND CONASAUGA FORMATIONS WERE DEPOSITED. PERIODIC INFLUXES OF TERRIGENOUS SEDIMENTS FROM REJUVENATED LANDS AND/OR MIGRATING FLUVIAL DISTRIBUTARY SOURCES, CREATED SANDY INTERVALS IN THE ROME AND CONASAUGA UNITS. THE OVERLYING KERBEL SANDSTONE REPRESENTS A PROMINENT INFLUX OF TERRIGENOUS SEDIMENTS FROM A LAND SOURCE TO THE NORTHWEST (JANSSENS, 1973; MAKI, 1986).

THE KNOX FORMATION CONSISTS OF DOLOMITE, SANDSTONE AND STRATIGRAPHICALLY AND GEOGRAPHICALLY RESTRICTED LIMESTONE. THE KNOX FORMATION VARIES SUBSTANTIALLY IN THICKNESS DUE TO ORIGINAL DEPOSITIONAL VARIATION AND SUBSEQUENT UPLIFT AND EROSIONAL REMOVAL, CREATING THE REGIONAL KNOX UNCONFORMITY. THE UNCONFORMITY IS REPORTED TO HAVE 150 TO 300 FEET OF RELIEF (JANSSENS, 1973; SHEARROW, 1987). ONLY THE LOWERMOST KNOX IS PRESERVED IN THE SITE AREA, WITH THE ZERO ISOPACH LOCATED JUST TO THE NORTH.

THE KNOX UNCONFORMITY IS BELIEVED TO HAVE ORIGINATED FROM THE EFFECTS OF INITIAL CONVERGENCE AND SUBDUCTION OF THE NORTH AMERICAN CRATON BENEATH CONTINENTAL PLATES OR MICROPLATES TO THE SOUTHEAST (RODGERS, 1971; SHANMUGAM AND LASH, 1982). A WIDE-SPREAD REGRESSIVE EVENT, CAUSED BY SEA LEVEL LOWERING AND/OR UPLIFT OF A "PERIPHERAL BULGE" RESPONDING TO INITIAL SUBSIDENCE OF THE APPALACHIAN FORELAND BASIN (TO THE SOUTHEAST) ARE SUGGESTED CAUSES OF THE KNOX EROSIONAL INTERVAL.

CONTINUED DEVELOPMENT OF THE APPALACHIAN BASIN RESULTED IN RENEWED LOWERING OF THE SITE REGION BELOW SEA LEVEL AND DEPOSITION OF THE WELLS CREEK, BLACK RIVER AND TRENTON FORMATIONS. SEDIMENTS DEPOSITED DURING THIS INTERVAL INCLUDE DOLOMITES, SANDSTONES, SHALES, SILTSTONES AND LIMESTONES. THE WELLS CREEK IS QUITE VARIABLE IN THICKNESS DUE TO LOCAL TOPOGRAPHIC IRREGULARITIES ON THE KNOX UNCONFORMITY SURFACE (SHEARROW, 1987).

FOLLOWING THE TRENTON, DEEPER MARINE CONDITIONS ARE INDICATED BY DEPOSITES OF FINE-GRAINED CLASTICS, WHICH INVADED THE CARBONATE PLATFORM ENVIRONMENT FROM A TACONIC UPLANDS SOURCE TO THE SOUTHEAST. A THICK SEQUENCE OF LIMEY CLASTICS AND INFREQUENT SILTY LIMESTONES, DESIGNATED THE CINCINNATIAN SERIES AND CAPPED BY THE QUEENSTON FORMATION, WAS DEPOSITED. AN EROSIONAL UNCONFORMITY, WHICH TRUNCATES THE CINCINNATIAN SERIES UNITS, MARKS THE BOUNDARY BETWEEN THE ORDOVICIAN AND SILURIAN PERIODS (TEXAS WORLD OPERATIONS, 1989).

THE UPPER SECTION OF THE STRATIGRAPHIC SEQUENCE BENEATH THE AREA INCLUDES THE BRASSFIELD, CABOT HEAD, DAYTON, AND ROCHESTER FORMATIONS. THESE ARE FOLLOWED BY THE LOCKPORT GROUP OF DOLOMITES OVERLAID BY LIMESTONES, DOLOMITES, AND EVAPORITES COMPRISING THE SALINA GROUP, INFORMALLY REFERRED TO AS THE BIG LIME. THE BIG LIME SUBCROPS BENEATH PLEISTOCENE AGE GLACIAL DEPOSITS OVER A WIDE AREA OF THE FINDLAY ARCH IN NORTHWESTERN OHIO (OWENS, 1970). A SIGNIFICANT EROSIONAL UNCONFORMITY OCCURS BETWEEN THE SILURIAN (400 MILLION YEARS AGO) AGE BIG LIME AND PLEISTOCENE AGE (10,000 YEARS AGO) DEPOSITS. THE GLACIAL DEPOSITS IN THE AREA ARE FURTHER DISCUSSED IN THE NEXT SECTION. A DETAILED DISCUSSION OF THE PALEOZOIC FORMATIONS, INCLUDING SEDIMENT TYPE, DEPOSITIONAL ENVIRONMENT AND PHYSICAL CHARACTERISTICS IS AVAILABLE IN THE GEOLOGIC SECTION OF THE CWM VICKERY LAND BAN PETITION (TEXAS WORLD OPERATIONS, 1989).

3.4.2 General Glacial Geology

The bedrock surface was altered and buried by the advance of the Pleistocene glaciers. Several different ice sheets advanced and retreated over the area, but only the youngest series of ice sheets, those that grew and retreated during the Wisconsinan stage, are recorded in the soil deposits. The surficial glacial geology of the area is presented in Figure 3-6. The facility is located along the southern edge of the former location of an ice lobe that came out of the Lake Erie basin from the north. As the ice from this advance retreated, the soil and rock material trapped within the ice was deposited as an unsorted till and sorted outwash deposits. Sandusky County lies within the ground moraine behind the Defiance end moraine, which marks one of the last major stands of the ice. As the ice retreated, the meltwaters were dammed between the high ground of the Defiance end moraine to the south and the ice which still existed to the north and the east, thus forming a series of pro-glacial lakes. The existence of these lakes is recorded in the forms of shorelines which developed along the margins of the water and silt and clay deposits that were formed in areas of the quiet water. The last major lake to have covered the facility area was probably Lake Lundy, whose shoreline was at an elevation of 620 feet above mean sea level. This lake was probably in existence at about 12,000 years ago.

~~The thickness of the glacial material underneath the facility ranges from 33 feet to 52 feet. The glacial material is comprised of lacustrine clay and glacial till. The lacustrine soils at the facility are generally comprised of laminated silty clay with occasional silt to fine sand partings between laminations. The lacustrine soil ranges from zero feet to twenty five feet in thickness, being absent in the southern portion of the facility.~~

~~The upper five to ten feet of soil at the facility has been desiccated in the geologic past. It has been noted during previous investigations (GOLDER, 1983) that below the limit of desiccation the lacustrine and/or till soils are usually soft, have a relatively high moisture content and appear normally consolidated. This is indicated by relatively low blow counts (four to ten) recorded from Standard Penetration Tests performed in borings, by laboratory analysis (e.g., Atterberg limits) and by the natural moisture contents being typically near the liquid limit of soils. BASED ON THE ATTERBERG LIMIT EVALUATIONS CONDUCTED DURING THE PREVIOUS INVESTIGATIONS, THE LIQUID LIMIT OF THE GLACIOLACUSTRINE/TILL MATERIAL VARIES FROM ABOUT 30% TO 40% AND THE PLASTIC LIMIT IS ABOUT 20%. THE WATER CONTENT OF THE MATERIAL, WHILE VARIABLE, TENDS TO INCREASE LINEARLY WITH DEPTH FROM ABOUT 15% TO 25% (ABOUT THE PLASTIC LIMIT)~~

~~NEAR THE TOP OF THE SURFICIAL DEPOSIT TO ABOUT 25% TO 35% (ABOUT THE LIQUID LIMIT) AT ABOUT AN ELEVATION OF 585 FT. ABOVE MEAN SEA LEVEL. SIMILARLY, THE STANDARD PENETRATION TEST RESISTANCE "N" VALUES IN THE SURFICIAL DEPOSIT DECREASE FROM ABOUT 10 TO 30 BLOWS/FT. NEAR THE TOP OF THE SURFICIAL DEPOSIT (STIFF TO VERY STIFF CONSISTENCY) TO ABOUT 3 TO 10 BLOWS/FT. AT ABOUT AN ELEVATION OF 585 FT. ABOVE MEAN SEA LEVEL (SOFT TO STIFF CONSISTENCY). THIS PATTERN OF DECREASING PENETRATION RESISTANCE AND INCREASING WATER CONTENT WITH DEPTH IS TYPICAL OF DESICCATION HARDENING ASSOCIATED WITH A GROUNDWATER TABLE AT ABOUT AN ELEVATION OF 580 FT ABOVE MEAN SEA LEVEL TO 590 FT. ABOVE MEAN SEA LEVEL DURING THE GEOLOGIC PAST.~~

~~Glacial till underlies the lacustrine soils and generally consists of an upper unit, which is continuous across the facility, and a lower unit which is discontinuous. The upper unit, which comprises the majority of the till deposit, is fairly well graded and generally consists of silty clay to clayey silt with some sand and gravel. It is relatively homogeneous in composition and exhibits no lamination, bedding or other distinct depositional structures. The lower discontinuous unit, a lodgement till, is somewhat coarser than the upper unit and is generally comprised of a silt with some sand, clay and gravel. The upper till unit ranges from eleven feet to thirty-eight feet in thickness and the lower till unit does not exceed thirteen feet in thickness, when present.~~

3.5 HYDROGEOLOGY

The glacial material, with the exception of buried sand and gravel valley deposits, yields very little water for domestic or commercial use. Major sources of groundwater in the area are the Salina Group and the Lockport dolomite, primarily due to the high degree of solutioning and jointing in the dolomite.

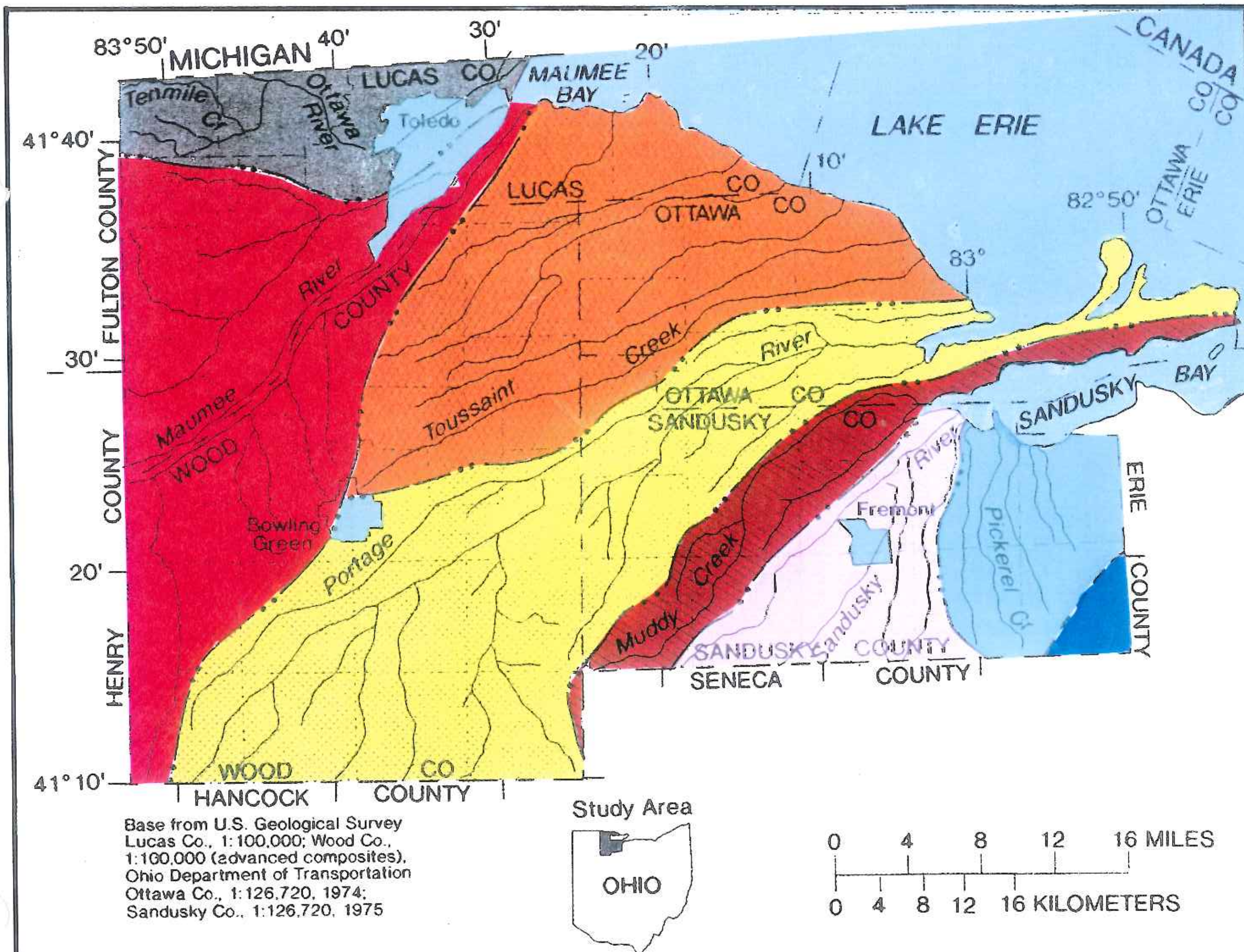
The uppermost bedrock aquifer in the area is the Salina Group. In this aquifer, regional groundwater flow in the area of the facility is to the north or to the north-northwest toward Lake Erie. The regional potentiometric surface in the upper carbonate bedrock is presented in Figure 3-7. The major groundwater recharge area for the aquifer in this area occurs approximately three to ten miles southeast of the facility, where the bedrock surface rises to within several feet of the ground surface. The recharge area reportedly has sinkholes and other karst features. The glacial overburden thickens to the northwest and acts as a confining layer (aquitard) at the facility (Breen et al 38-43).

REGIONAL GROUNDWATER FLOW IN THE AREA IS GENERALLY TOWARD LAKE ERIE IN A NORTH OR NORTHWESTERLY DIRECTION. THE FLOW SYSTEM APPEARS TO DISCHARGE BENEATH LAKE ERIE (FIGURE 3-7). IT SHOULD BE NOTED THAT THESE GROUNDWATER CONTOURS REPRESENT AN AVERAGE VALUE OF HYDRAULIC HEAD OBTAINED FROM WELLS WHICH ARE COMPLETED AT DIFFERENT DEPTHS AND IN DIFFERENT FORMATIONS WITH THE BEDROCK IN THE AREA. FOR THIS REASON, SOME LOCAL VARIATION IN FLOW DIRECTION AND GRADIENT MAY BE EXPECTED.

Flowing artesian conditions from the bedrock aquifer exist around the facility in Riley, Green Creek and Townsend Townships. At these locations, the aquifer potentiometric surface rises above the ground surface, resulting in flowing wells and springs. The artesian heads observed in these wells further suggests that recharge occurs south to southeast of the facility at higher elevations (Breen et. al. 45). The well for the Ohio Turnpike service plaza, located one mile to the east of the facility, was reported as a flowing well when it was installed with a head 14 feet above the ground surface. Also, Poor Man's Spring, an artesian spring, is located about one-half mile south of the facility. ALTHOUGH THESE ARTESIAN CONDITIONS EXIST WITHIN THE BEDROCK AQUIFER AROUND THE FACILITY, NO ARTESIAN CONDITIONS EXIST IN ANY OF THE WELLS AT THE FACILITY.

Potentiometric level data has been collected over several years in the region by the USGS, and at the facility by CWM and subcontracted consulting companies. Groundwater levels within the region generally increase during the winter to a high level in March and then decrease to a low in August.

FIGURES



Base from U.S. Geological Survey
Lucas Co., 1:100,000; Wood Co.,
1:100,000 (advanced composites),
Ohio Department of Transportation
Ottawa Co., 1:126,720, 1974;
Sandusky Co., 1:126,720, 1975

EXPLANATION

- KARST AREA BOUNDARY--Area of underground drainage. Dashed where approximately located
- DRAINAGE BASIN BOUNDARY
- MAUMEE RIVER BASIN
- MUDDY CREEK BASIN
- PICKEREL CREEK BASIN
- PORTAGE RIVER BASIN
- SANDUSKY RIVER BASIN
- TENMILE CREEK AND OTTAWA RIVER BASIN
- TOUSSAINT CREEK BASIN AND ADJACENT LAKE ERIE TRIBUTARIES

SOURCE :
USGS WATER RESOURCES INVESTIGATION REPORT 91-4024

RUST ENVIRONMENT & INFRASTRUCTURE

SIGNATURE

DATE

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DATE: DECEMBER, 1994
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SCALE: AS SHOWN

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DRN BY	JAT
CHK BY	RZ
REV BY	
APP BY	

PROJECT: RCRA FACILITY INVESTIGATION

SHEET TITLE:

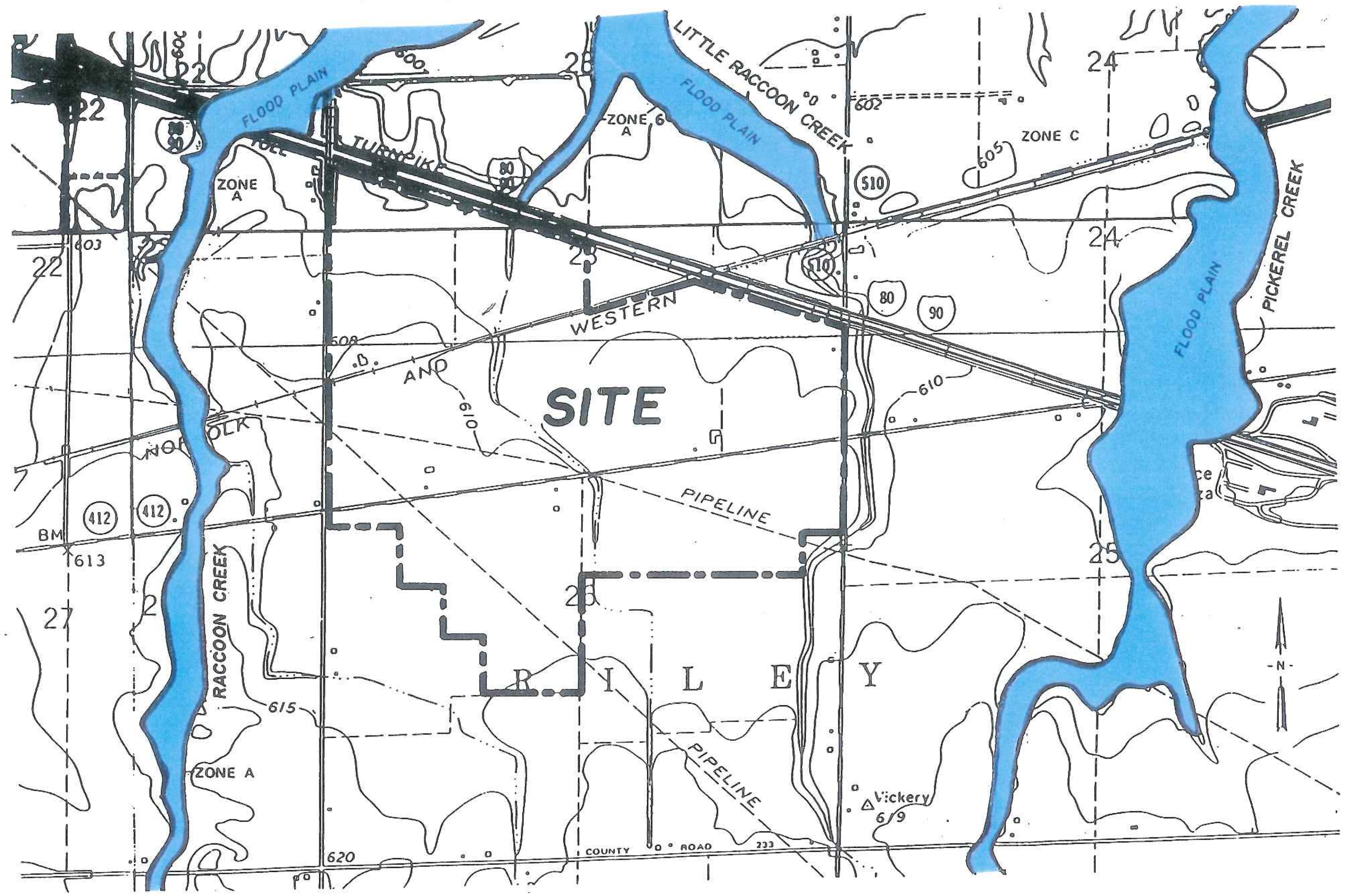
REGIONAL DRAINAGE BASINS

CWM-Vickery
Vickery, Ohio

SHEET ____ OF ____

DRAWING NO.

FIGURE 3-1



REFERENCE : HUD FLOOD INSURANCE RATE MAP (1979)

REV.	DATE		DRN BY	APP BY

DATE:	DECEMBER, 1994
DES BY	
DRN BY	JAT
CHK BY	RZ
REV BY	
APP BY	

PROJECT NO. 38627 | SCALE: NOT TO SCALE

PROJECT: RCRA FACILITY INVESTIGATION

SHEET TITLE:

100 YEAR FLOOD PLAIN

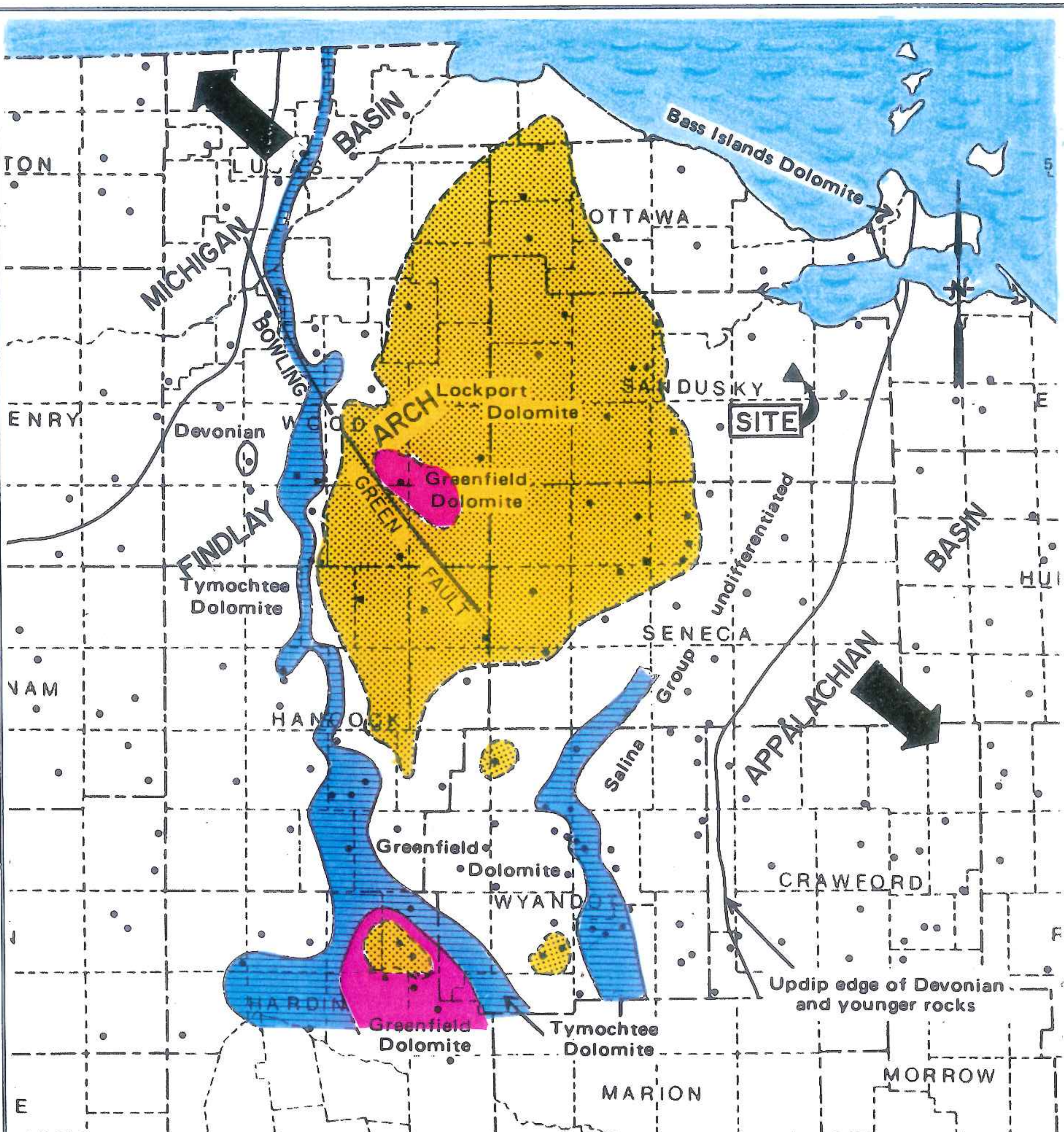
RUST ENVIRONMENT & INFRASTRUCTURE

CWM-Vickery
Vickery, Ohio

SHEET ____ OF ____

DRAWING NO.

FIGURE 3-2



SOURCE :

STATE OF OHIO DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF GEOLOGICAL SURVEY
REPORT OF INVESTIGATIONS NO. 100

LEGEND

- LOCKPORT DOLOMITE
- TYMOCHTEE DOLOMITE
- GREENFIELD DOLOMITE
- BASIN DIRECTION
- FAULT

RUST ENVIRONMENT & INFRASTRUCTURE

SIGNATURE

DATE

REV.	DATE	DESCRIPTION	DRN BY	APP BY

DATE: DECEMBER, 1994

PROJECT NO. 38627

SCALE: NOT TO SCALE

DES BY

DRN BY JAT

CHK BY RZ

REV BY

APP BY

PROJECT: RCRA FACILITY INVESTIGATION

SHEET TITLE:

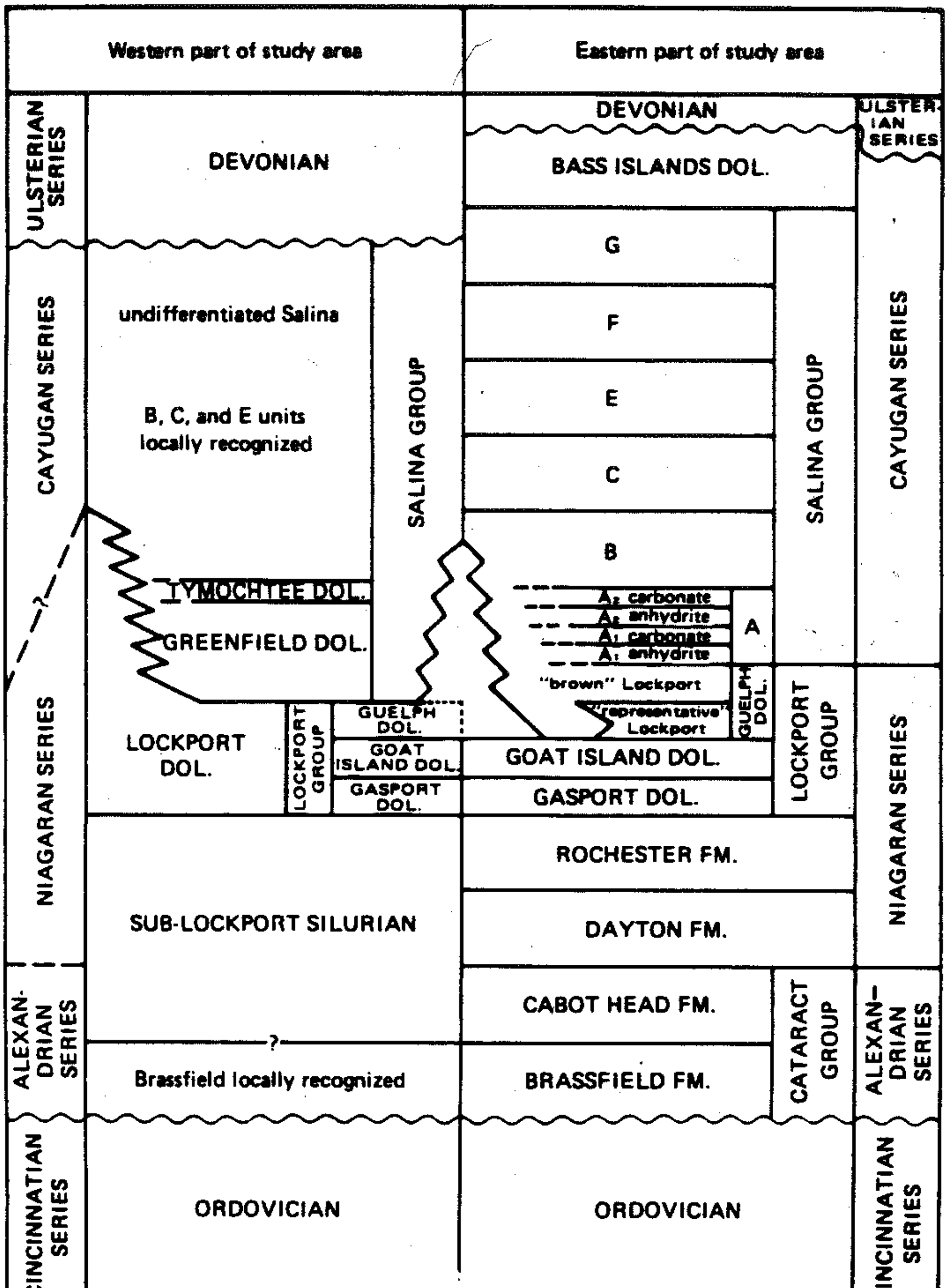
SILURIAN BEDROCK GEOLOGY OF NORTHWESTERN OHIO

CWM-Vickery
Vickery, Ohio

SHEET ____ OF ____

DRAWING NO.

FIGURE 3-3



SOURCE :

STATE OF OHIO DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF GEOLOGICAL SURVEY
REPORT OF INVESTIGATIONS NO. 100

RUST ENVIRONMENT & INFRASTRUCTURE

SIGNATURE

DATE

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DATE: DECEMBER, 1994

PROJECT NO. 38627

SCALE: NOT TO SCALE

DES BY

DRN BY JAT

CHK BY RZ

REV BY

APP BY

PROJECT:
RCRA FACILITY INVESTIGATION

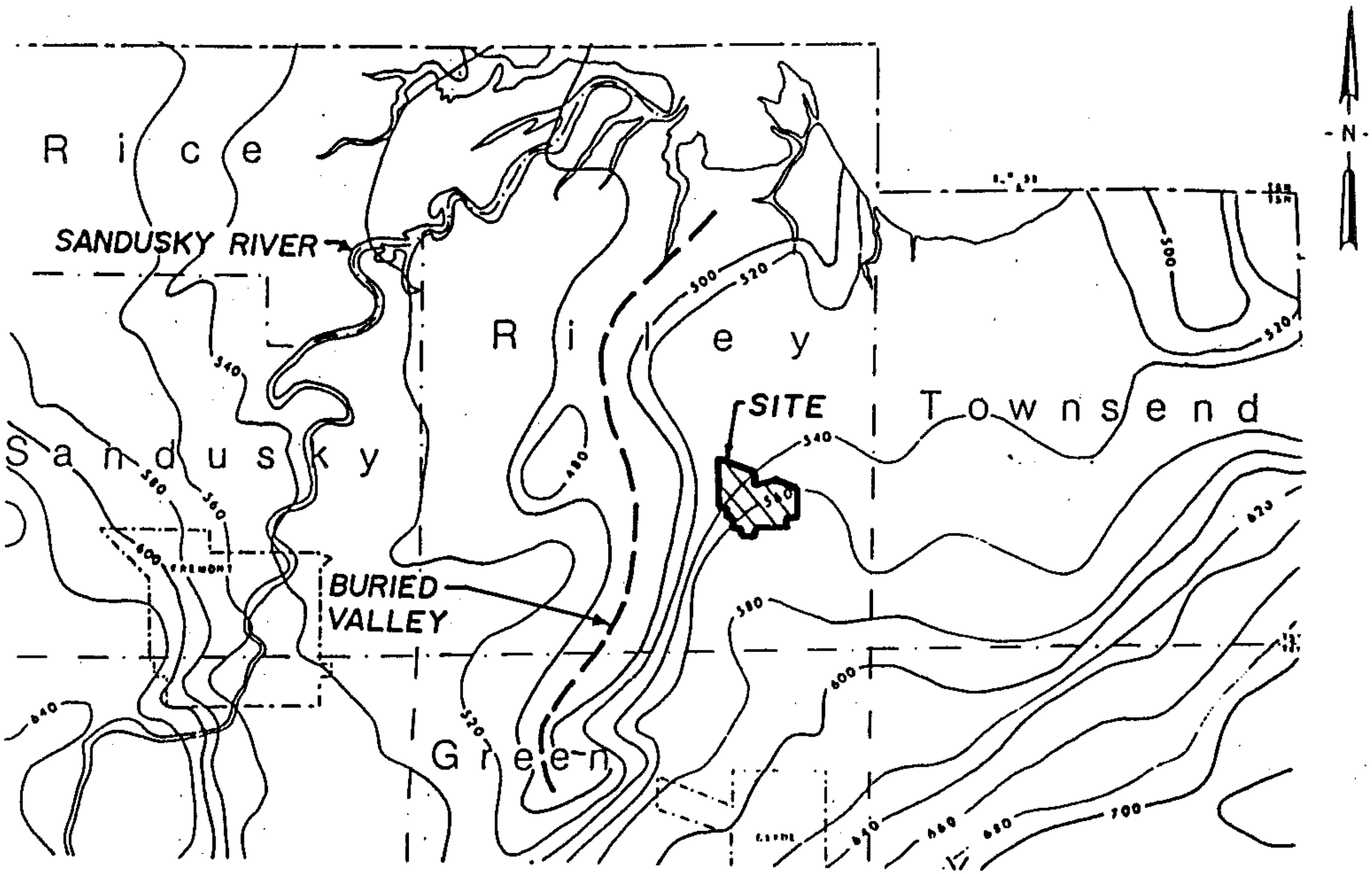
SHEET TITLE:
STRATIGRAPHIC COLUMN OF THE SILURIAN ROCKS OF NORTHWESTERN OHIO

CWM-Vickery
Vickery, Ohio

SHEET ____ OF ____

DRAWING NO.

FIGURE 3-4



0 2.37 4.74

SCALE : 1" = 2.37 MILES (APPROX.)

SOURCE :

BOWSER-MORNER 1983 HYDROGEOLOGICAL ASSESSMENT.

RUST ENVIRONMENT & INFRASTRUCTURE

SIGNATURE

DATE

REV.	DATE	DESCRIPTION	DRN BY	APP BY

DATE: DECEMBER, 1994

DES BY

DRN BY JAT

CHK BY RZ

REV BY

APP BY

PROJECT NO. 38627

SCALE: AS SHOWN

PROJECT: RCRA FACILITY INVESTIGATION

SHEET TITLE:

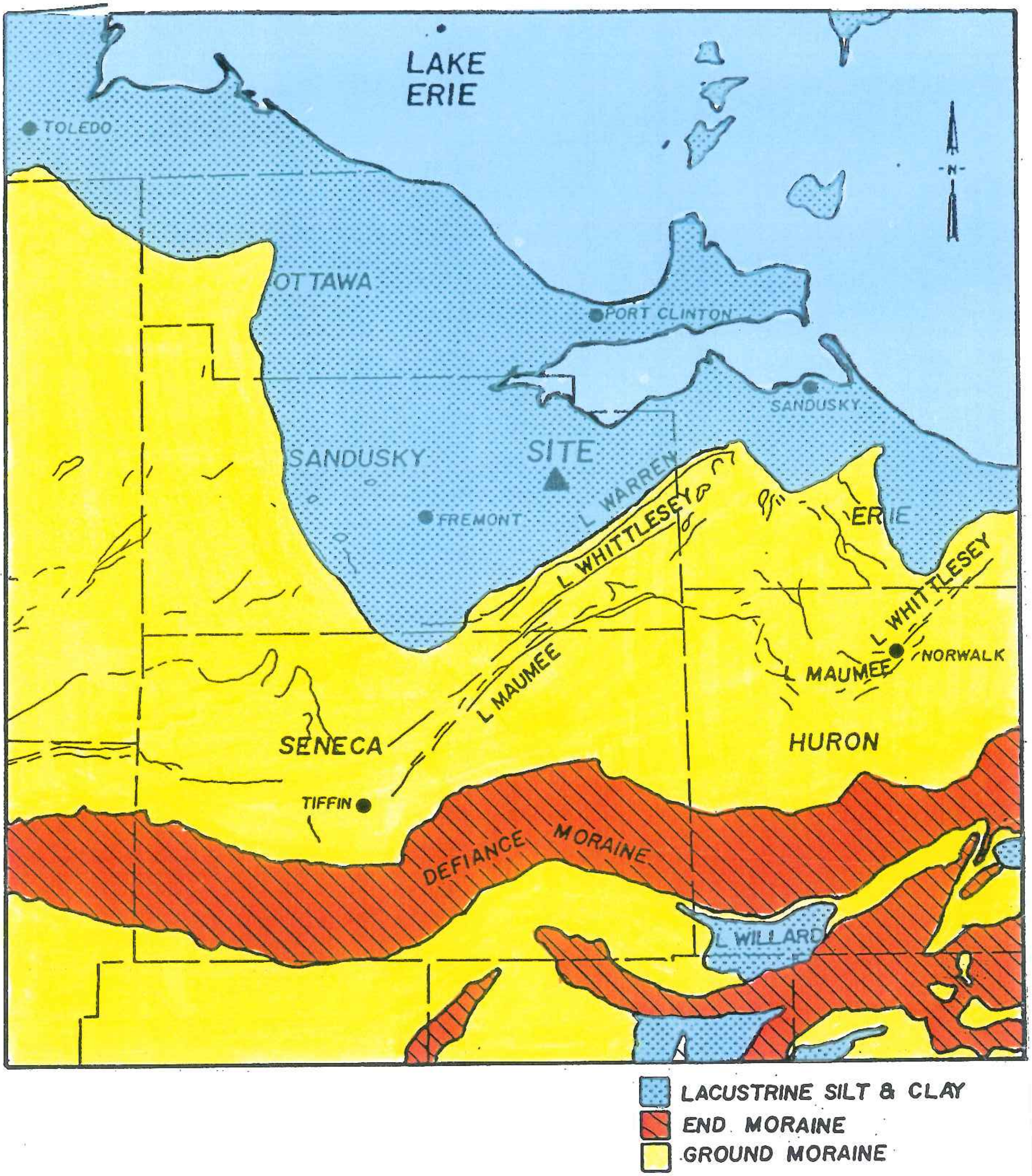
BEDROCK TOPOGRAPHY

CWM-Vickery
Vickery, Ohio

SHEET ___ OF ___

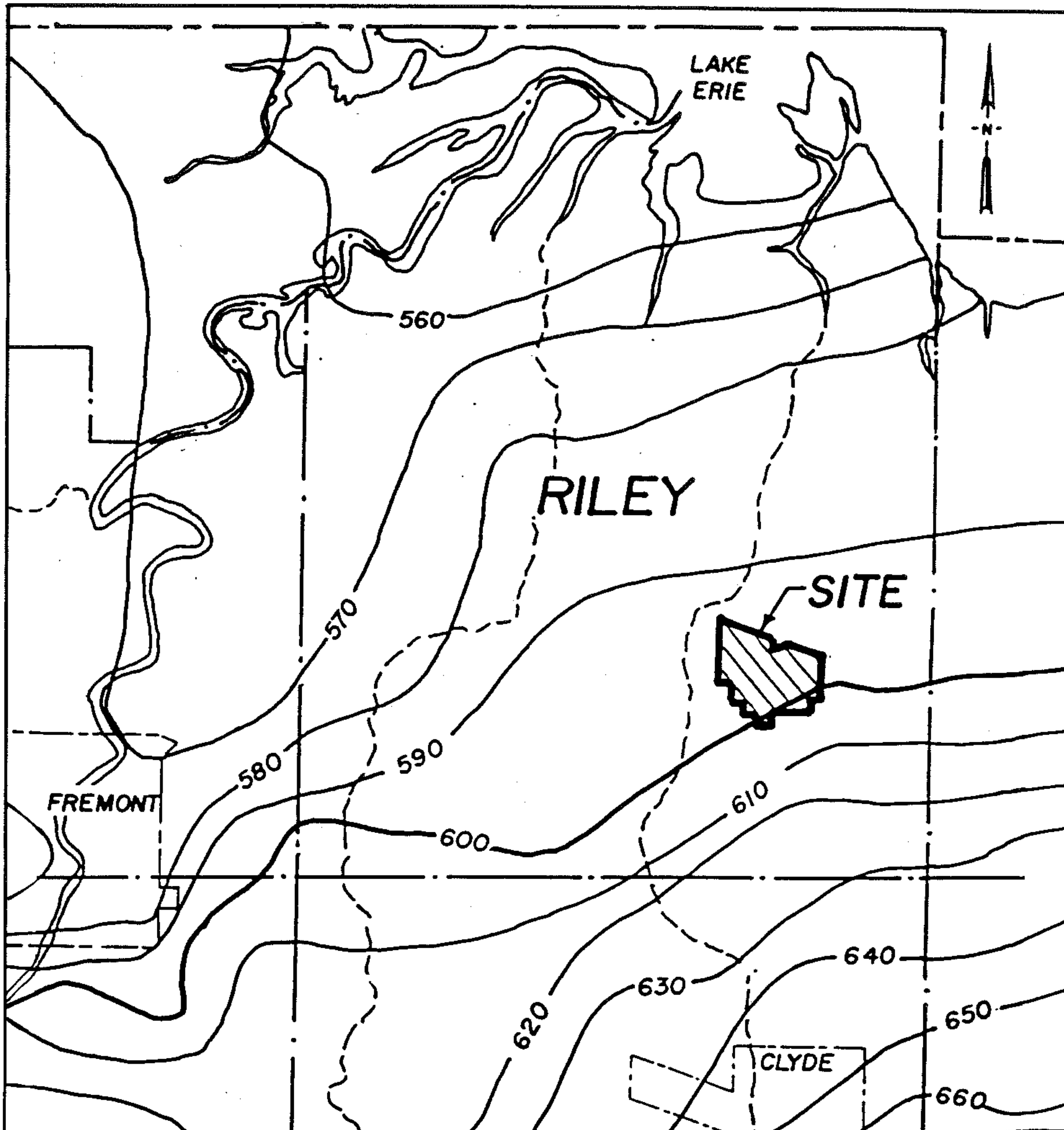
DRAWING NO.

FIGURE 3-5



SOURCE :
FROM GOLDTHWAIT ET AL. (1961)

RUST ENVIRONMENT & INFRASTRUCTURE	REV.	DATE	DESCRIPTION	DRN BY	APP BY
SIGNATURE	DATE: DECEMBER, 1994		PROJECT NO. 38627	SCALE: NOT TO SCALE	
DATE	DES BY		PROJECT: RCRA FACILITY INVESTIGATION		
	DRN BY	JAT	SHEET TITLE: SURFICIAL GLACIAL GEOLOGY		
	CHK BY	RZ			
	REV BY				
	APP BY				
	CWM-Vickery Vickery, Ohio			SHEET ___ OF ___	
				DRAWING NO. FIGURE 3-6	



— 610 — GROUND WATER SURFACE CONTOUR LINE

SOURCE :
BOWSER-MORNER 1983 HYDROGEOLOGICAL ASSESSMENT. AFTER HOOVER 1982

RUST ENVIRONMENT & INFRASTRUCTURE

SIGNATURE

DATE

REV.	DATE	DESCRIPTION	DRN BY	APP BY

DATE: DECEMBER, 1994

PROJECT NO. 38627

SCALE: NOT TO SCALE

DES BY	
DRN BY	JAT
CHK BY	RZ
REV BY	
APP BY	

PROJECT: RCRA FACILITY INVESTIGATION

SHEET TITLE:

POTENTIOMETRIC SURFACE MAP OF THE BEDROCK AQUIFER

CWM-Vickery
Vickery, Ohio

SHEET ____ OF ____

DRAWING NO.

FIGURE 3-7

4.0 SITE PHYSIOGRAPHY/GEOLOGY

4.1 SITE TOPOGRAPHY

The topography of the facility is relatively level with elevations generally ranging from 600 to 616 feet above mean sea level with a slight slope to the north. However, various relatively recent site activities have altered the site topography. The closure of ~~ponds~~ SURFACE IMPOUNDMENTS 4, 5, 7, 11 and 12 has significantly redefined the local site topography. Additionally, non-facility structures, such as the abandoned railroad grade and the Ohio Turnpike embankment have altered the natural topography in the area. Figure 4-1 presents the site topography.

4.2 SURFACE WATER HYDROLOGY

Site runoff is controlled by a ditch and flow control gate system. Runoff is either contained or allowed to discharge from the site at selected locations (Figure 4-2). All fluids which originate at these locations are able to be contained for subsequent discharge by the flow control gate system.

Drainage outside the site operational perimeter dike system flows into Little Raccoon Creek via roadside ditches along State Route 510, or into an intermittent tributary called Meyers Ditch near the west-central portion of the facility. Meyers Ditch leaves the site at the northern boundary under the Ohio Turnpike.

The facility is not located within the 100-year flood plain of any surface water features. (Figure 3-1).

4.3 GEOLOGY AND SOILS

4.3.1 Site Bedrock Geology

Bedrock under the facility is composed of dolomites of the Salina Group. The dolomite is found from 40 to 50 feet below the surface at elevations ranging from 554 to 576 feet above mean sea level. Boring information available from previous investigations indicate the bedrock surface to be somewhat variable, although for the most part it is sloping gently towards the north. ~~The bedrock surface also indicates an apparent small valley, or, more properly, a gully running~~

~~approximately north/south through the center of the site.~~ AN APPARENT SMALL VALLEY OR GULLY APPEARS TO TREND SOUTHWEST TO NORTHEAST TOWARDS THE SOUTHEAST OF THE ACTIVE AREA OF THE FACILITY. The top of bedrock contours are presented in Figure 4-3. ~~The small gully has a maximum depth of about ten feet~~. THIS SMALL GULLY APPEARS TO HAVE AN AVERAGE DEPTH OF TWO FEET.

Detailed rock core logs collected during previous investigations conducted at the facility indicated the bedrock here is a mixture of shale, dolomite, gypsum, and anhydrite. The variation of the bedrock type makes correlation of the bedrock across the site difficult. However, a black shale does appear to exist across most of the site. This black shale is interbedded with gypsum layers of varying thickness. The dolomite that is present is very shaley and also contains gypsum.

Gypsum occurs in all possible forms under the facility. Anhydrite, gypsum's dehydrated form, was also present in some of the rock cores collected. The gypsum was found as crystals lining open voids, veins that both parallel and crosscut bedding as massive white or gray units, and as very small brown crystalline spheres. These brown spheres were found only in the deepest core, at or below an elevation of 510 feet.

Solutioning was evident in all of the cores collected at the facility; however, none of the cores were documented as encountering any large cavities or caverns. Most open voids were between one-quarter and one-half inch in maximum observable dimensions. These voids were most common below an elevation of 560 feet. NO PERMEABILITY TESTS WERE PERFORMED ON BEDROCK CORES. HOWEVER, THE CHARACTERISTICS OF THE BEDROCK WERE DETERMINED BY A PUMPING TEST CONDUCTED BY BOWSER MORNER IN 1982 AND PRESSURE PACKER TESTS BY GOLDER ASSOCIATES IN 1983. THE RESULTS OF THESE TESTS ARE DETAILED IN SECTION 4.4.2 - GROUNDWATER IN THE BEDROCK. In addition to open voids, bedding planes appeared to have offered easy avenues for solutioning, as zones containing highly weathered shale but no gypsum were documented as being common. These weathered zones were on the order of one-half foot to one foot in thickness. It is apparent that groundwater is moving along fractures and joints within the bedrock. The groundwater flow has probably dissolved much of the gypsum along these fractures and probably continues to do so.

4.3.1.2 Deep Well System Site Bedrock Geology

THE CWM-VICKERY FACILITY IS LOCATED, AS PREVIOUSLY DISCUSSED, EAST OF THE CREST OF THE FINDLAY ARCH. SEVEN DEEP INJECTION WELLS ARE LOCATED WITHIN APPROXIMATE ONE SQUARE MILE AREA AT THE CWM - VICKERY FACILITY. THE DENSITY OF THIS CONTROL REVEALS THE SUBTLE DETAIL OF THE LOCAL STRUCTURE AT THE CWM - VICKERY FACILITY. A DETAILED DESCRIPTION OF THE DEEP BEDROCK GEOLOGY AT THE SITE IS DISCUSSED IN THE CWM VICKERY LAND BAN PETITION COMPLETED BY TEXAS WORLD OPERATIONS (TWO) IN 1989.

THE STRATIGRAPHY OF THE DEEP BEDROCK GEOLOGY AT CWM VICKERY SITE HAS BEEN DERIVED FROM WELL LOGS AND DESCRIPTIONS OF DRILL CUTTINGS AND CORES. ADDITIONALLY, A MORE SPECIFIC MEGASCOPIC AND MICROSCOPIC STUDY OF THE CORES AS COMPLETED. A BRIEF DESCRIPTION OF THE STRATIGRAPHY IS PROVIDED IN THE FOLLOWING PARAGRAPHS.

PRECAMBRIAN BASEMENT ROCK

THE PRECAMBRIAN BASEMENT IS DOCUMENTED AS RANGING IN DEPTH FROM 2884 FT (-2266 FT BELOW SEA LEVEL) TO 3092 FT (-2441 FT BELOW SEA LEVEL). THE BASEMENT SAMPLES WERE DETERMINED TO BE COMPRISED OF MEDIUM GRAINED GRANITE COMPOSED OF PINK ORTHOCLASE AND QUARTZ, WITH ACCESSORY BIOTITE AND PLAGIOCLASE. THE BASEMENT ROCK FOLIATION WHICH OCCURS WAS ORIGINALLY BELIEVED TO BE PRODUCED BY METAMORPHISM, BUT MORE LIKELY, AS DETERMINED BY TWO, AS A RESULT OF SYNTECTONIC INTRUSION OF MAGMA. THIS THEORY WAS BASED ON LIGHTLY SUTURED GRAIN CONTACTS AND A LACK OF COMPOSITIONAL BANDING.

INJECTION INTERVAL/MT. SIMON SANDSTONE

ABOVE THE BASEMENT ROCK IS THE INJECTION INTERVAL, KNOWN AS THE MT. SIMON SANDSTONE. THE MT. SIMON SANDSTONE UNCOMFORMABLY OVERLIES THE PRECAMBRIAN BASEMENT ROCK. THIS SANDSTONE RANGES IN THICKNESS FROM 147 FT TO 84 FT AND AVERAGES APPROXIMATELY 122 FT THICK. THE

VARIATION OF THE THICKNESS IS LARGELY CONTROLLED BY RELIEF ON THE BASEMENT ROCK SURFACE. THE MT. SIMON IS COMPOSED OF MODERATELY TO WELL SORTED, VERY-FINE TO COARSE-GRAINED SANDSTONE. THESE SANDS CONTAIN LOW QUANTITIES OF DETRITAL CLAY, BUT AUTHIGENIC GRAIN-COATING CHLORITE IS FAIRLY COMMON. DOLOMITE CEMENT AND INTERBEDDED DOLOMITES ARE SPORADICALLY DISTRIBUTED THROUGHOUT THE SANDSTONES.

CONTAINMENT INTERVAL

ABOVE THE MT. SIMON SANDSTONE IS THE CONTAINMENT INTERVAL WHICH CONSISTS OF THE ROME, CONASAUGA, KERBEL AND KNOX FORMATIONS. THIS INTERVAL CONSISTS OF APPROXIMATELY 440 FT OF DOLOMITES AND SANDSTONES AND ACTS AS A BARRIER TO WASTE MOVEMENT OUT OF THE MT. SIMON SANDSTONE.

ROME FORMATION

THE ROME FORMATION CONSISTS PRIMARILY OF WELL SORTED, DOLOMITIZED GRAINSTONES, PACKSTONES, AND WACKESTONES. CLAYS ARE RARE, TENDING TO BE CONCENTRATED NEAR THE BASE OF THE BIOTURBATED, COARSENING UPWARD SANDSTONE FACIES. SOME VERY THIN AGRILLACEOUS LAMINATION ZONES ARE PRESENT THROUGHOUT, AS WELL AS SOME PYRITE. THE FINE GRAINED ARGILLACEOUS NATURE OF THE SAMPLES FROM THE VICKERY SITE INDICATES THAT THE CARBONATES OF THE ROME FORMATION MOST LIKELY FORMED IN AN ENVIRONMENT OF RELATIVELY LOW ENERGY.

CONASAUGA FORMATION

THE CONTACT BETWEEN THE ROME AND THE OVERLYING CONASAUGA FORMATION IS EASILY DISTINGUISHABLE ON ELECTRIC LOGS (TWO). THE LOWER PORTION OF THE CONASAUGA FORMATION CONSISTS OF WELL TO VERY WELL SORTED, VERY FINE TO FINE GRAINED SANDSTONES CONTAINING RELATIVELY RARE DISCONTINUOUS SHALE LAMINAE AND ABUNDANT FLAT PEBBLE CONGLOMERATES. DOLOMITE CEMENTS ARE COMMON THROUGHOUT. THE UPPER CONASAUGA DISPLAYS A WIDE VARIETY OF INTERBEDDED LITHOLOGIES, INCLUDING WAVY BEDDED SHALES AND SILTSTONES, GLAUCONITIC SANDSTONE,

AND THINLY BEDDED DOLOMITIZED MUDSTONES. CLAY MATRIX AND BIOTURBATION ARE COMMON. THESE INTERBEDDED SANDS AND SHALES GRADE UPWARD INTO THE VERY WELL SORTED SANDSTONES OF THE KERBEL FORMATION.

KERBEL FORMATION

THE GLAUCONTIC, FINE GRAINED SANDS OF SILTS OF THE CONSAUGA FORMATION GRADE UPWARD INTO THE DOLOMITIC SAND OF THE KERBEL FORMATION. AVERAGE THICKNESS OF THIS FORMATION AT THE CWM VICKERY SITE IS APPROXIMATELY 58 FT. THE KERBEL FORMATION CONSISTS OF DOLOMITIC, VERY FINE TO MEDIUM GRAINED SANDSTONES WHICH DISPLAY ONLY MINOR VARIATIONS IN SEDIMENTARY FABRIC. SUBROUNDED TO ROUNDED, EQUANT TO SUBEQUANT FRAMEWORK GRAINS TEND TO BE WELL TO VERY WELL SORTED. OVERALL CLAY CONTENT IS VERY LOW, RANGING FROM TRACE TO 3.0%. ABUNDANT DOLOMITE CEMENT WITH THE FORMATION REDUCES THE OVERALL POROSITY.

KNOX FORMATION

THE KNOX FORMATION AVERAGES APPROXIMATELY 55 FT IN THICKNESS AT THE SITE. THE CONTACT BETWEEN THE UPPER KERBEL AND THE BASE OF THE KNOX IS GRADATIONAL, WITH DOLOMITE CONTENT INCREASING UPWARD. THE KNOX SAMPLES RANGE FROM DOLOMITIC SANDS NEAR THE BASE TO DOLOMITIZED GRAINSTONES/PACKSTONES HIGHER IN THE SECTION. FRAMEWORK GRAINS ARE SUBANGULAR TO WELL ROUNDED, WITH MANY CARBONATE PARTICLES HAVING BEEN COMPLETELY REPLACED BY DOLOMITE. WHERE CLASTIC CONTENT IS HIGH AND WHERE PARTICLES CAN STILL BE DISCERNED, SORTING VARIES FROM MODERATE TO VERY WELL. POROSITY TENDS TO BE POORLY TO MODERATELY DEVELOPED.

CONFINING ZONE

THE CONFINING ZONE IS COMPOSED OF THE WELLS CREEK AND THE BLACK RIVER FORMATIONS. THESE FORMATIONS, AS DISCUSSED BELOW, CONSIST OF LIMESTONES AND SHALES APPROXIMATELY 545 FT IN TOTAL THICKNESS.

THE MIDDLE ORDOVICIAN WELLS CREEK FORMATION UNCONFORMABLY OVERLIES THE CAMBRIAN KNOX FORMATION. THE WELLS CREEK REPRESENTS A BRIEF PERIOD OF MIXED CLASTIC AND CARBONATE SEDIMENTATION AND IS DESCRIBED AS A LIMEY, BLUISH GREY TO GREEN SHALE. THICKNESS OF THE WELLS CREEK RANGES FROM 2 TO 10 FT, WITH THE THICKNESS CONTROLLED BY THE EROSIONAL KNOX SURFACE. THE WELLS CREEK HAS BEEN DESCRIBED IN A WELL NEAR THE SITE AS A GREEN TO VERY DARK GREEN, WAXY IN PART, GLAUCONITIC, SLIGHTLY DOLOMITIC, WITH HEAVY TRACES OF PYRITE.

THE BLACK RIVER LIMESTONE OVERLIES THE WELLS CREEK FORMATION AND AVERAGES 540 FT THICK AT THE SITE. THE BLACK RIVER LIMESTONE CONSISTS OF LIGHT BROWN TO CREAM, VERY FINE-TO-FINELY CRYSTALLINE LIMESTONE WITH VERY THIN STRINGERS OF GREEN SHALE. THE BLACK RIVER GROUP IS A WELL DOCUMENTED EXAMPLE OF A TRANSGRESSIVE, UPWARD-DEEPENING SEQUENCE BEGINNING WITH INTERTIDAL-SUPRATIDAL FACIES AND GRADING UPWARD INTO SHALLOW-WATER, SUBTIDAL MUDDY LIMESTONE (ENOS, 1983). THIS IS DEMONSTRATED BY THE INCREASE IN SHALE CONTENT NEAR THE UPPER PORTION OF THE FORMATION NOTED IN THE CWM VICKERY DRILL CUTTING DESCRIPTIONS.

THE FORMATIONS OF THE CONFINING ZONE REPRESENT AN ASSEMBLEDGE OF APPROXIMATELY 545 FT OF GENERALLY FINE GRAINED ROCK MATERIALS, THE GREAT MAJORITY OF WHICH PRESENTLY EXHIBIT RELATIVELY LOW POROSITY AND PERMEABILITY. THE EXISTENCE OF THIS MASSIVE ZONE ABOVE THE INJECTION ZONE FORMS A HYDRAULIC BARRIER WHICH PROVIDES ADDITIONAL PROTECTIONS, ABOVE AND BEYOND THE INJECTION ZONE, AGAINST MIGRATION OF WASTES INTO ANY UNDERGROUND SOURCE OF DRINKING WATER (USDW).

TRENTON LIMESTONE

THE TRENTON LIMESTONE OVERLIES THE BLACK RIVER FORMATION. THE MAIN LITHOLOGIC DIFFERENCE BETWEEN THE BLACK RIVER AND THE TRENTON LIMESTONES IS THE UPWARD CHANGE FROM LIME MUDSTONES TO COARSER GRAINED LIMESTONE AND DOLOMITE. THE TRENTON IS PRIMARILY A FOSSILIFEROUS, DARK GRAY TO LIGHT BROWN FINELY CRYSTALLINE

LIMESTONE. COMMON THROUGHOUT THE FORMATION ARE THIN GREY TO BLACK SHALE BEDS AND STYOLITES. THE TRENTON LIMESTONE IS APPROXIMATELY 160 FT THICK AT THE SITE.

CINCINNATIAN SERIES

THE CINCINNATIAN SERIES OF UNDIFFERENTIATED SILTS AND SHALES OVERLIES THE TRENTON LIMESTONE AND IS APPROXIMATELY 800 FEET THICK. THE NAME CINCINNATIAN SERIES, A TIME-STRATIGRAPHIC TERM, IS RESTRICTED TO ROCKS OF LATE ORDOVICIAN AGE. MOST OF THE "FORMATIONS" ASSIGNED TO THE CINCINNATIAN SERIES ARE ACTUALLY BIOSTRATIGRAPHIC ZONES. THE CINCINNATIAN SERIES IS COMPOSED PRIMARILY OF SHALES WHICH MAY BE LIGHT TO DARK GRAY OR BLACK, OCCASIONALLY GREEN, SILTY IN PART, AND INTERBEDDED WITH THIN LIMESTONE BEDS. FOSSILIFEROUS ZONES ARE NOT UNCOMMON, AND TRACES OF PYRITE ARE PRESENT NEAR THE BASE OF THE SERIES.

CATARACT GROUP

THE CATARACT GROUP, WHICH SITS ABOVE AN EROSIONAL UNCONFORMITY WHICH MARKS THE UPPER BOUNDARY OF THE CINCINNATIAN SERIES AND MARKS THE APPROXIMATE SYSTEMIC BOUNDARY BETWEEN THE ORDOVICIAN AND SILURIAN, CONSISTS OF THE BRASSFIELD FORMATION AND THE CABOT HEAD FORMATION. THESE TWO FORMATIONS WERE DEPOSITED IN ASCENDING ORDER ABOVE THE UNCONFORMITY. THE BRASSFIELD, WHICH HAS BEEN DETERMINED TO BE THE BASE OF THE LOWEST USDW UNDER THE SITE, CONSISTS GENERALLY OF DOLOMITIZED COARSE GRAINED LIMESTONE THAT MAY BE CHERT BEARING, GLAUCONITIC OR SILTY IN THE LOWERMOST PART. THE BRASSFIELD GRADES UPWARD INTO INTERBEDDED GREEN AND REDDISH-BROWN SHALE AND DOLOMITIZED, PARTLY HEMATITIC, COARSE GRAINED LIMESTONE WHICH MAKES UP THE CABOT HEAD FORMATION. THE APPROXIMATE THICKNESS OF THE CATARACT GROUP IS 140 FT.

DAYTON FORMATION

OVERLYING THE CATARACT GROUP IS THE DAYTON FORMATION WHICH IS COMPOSED OF THIN DOLOMITIZED LIMESTONES WHICH MAY BE LOCALLY SEPARATED BY A GREEN SHALE MEMBER. THE THICKNESS OF THE DAYTON FORMATION, WHICH IS BELIEVED TO BE THE BASE OF THE FRESH WATER UNDER THE SITE, IS 10 FT.

ROCHESTER FORMATION

THE ROCHESTER FORMATION OVERLIES THE DAYTON FORMATION WHICH IS DESCRIBED AS A GREEN, GREY AND DARK BROWN SHALE OR ARGILLACEOUS DOLOMITE (JANSSENS, 1977). THE THICKNESS OF THE ROCHESTER FORMATION AT THE SITE IS 15 FT.

LOCKPORT GROUP

THE LOCKPORT GROUP OVERLIES THE ROCHESTER FORMATION. THE LOCKPORT, IN ASCENDING ORDER, MAY BE COMPOSED OF CRINOIDAL GRAY DOLOMITE; A FINELY CRYSTALLINE BROWN DOLOMITE WHICH MAY CONTAIN CHERT; AND A COARSELY CRYSTALLINE GRAY AND WHITE DOLOMITE. THE THICKNESS OF THE LOCKPORT GROUP UNDER THE SITE IS APPROXIMATELY 360 FT.

SALINA GROUP

THE LOCKPORT GROUP IS OVERLAIN BY THE EVAPORITE SEQUENCES. THESE SEQUENCES ARE CORRELATED TO THE UNDIFFERENTIATED FORMATIONS OF THE SALINA GROUP. THE THICKNESS OF THE SALINA GROUP AT THE CWM VICKERY FACILITY IS APPROXIMATELY 200 FT. OVERLYING THE SALINA GROUP IS THE PLEISTOCENE AGE GLACIAL MATERIAL FOUND AT THE SITE.

4.3.2 Site Glacial Geology

THE THICKNESS OF THE GLACIAL MATERIAL UNDERNEATH THE FACILITY RANGES FROM 33 FEET TO 52 FEET. THE GLACIAL MATERIAL IS COMPRISED OF LACUSTRINE CLAY AND GLACIAL TILL. THE LACUSTRINE SOILS AT THE FACILITY ARE GENERALLY COMPRISED OF LAMINATED SILTY CLAY WITH OCCASIONAL SILT TO FINE SAND PARTINGS BETWEEN LAMINATIONS. THE LACUSTRINE SOIL RANGES FROM ZERO FEET TO TWENTY FIVE FEET IN THICKNESS, BEING ABSENT IN THE SOUTHERN PORTION OF THE FACILITY.

THE UPPER FIVE TO TEN FEET OF SOIL AT THE FACILITY HAS BEEN DESICCATED IN THE GEOLOGIC PAST. IT HAS BEEN NOTED DURING PREVIOUS INVESTIGATIONS (GOLDER, 1983) THAT BELOW THE LIMIT OF DESICCATION THE LACUSTRINE AND/OR TILL SOILS ARE USUALLY SOFT, HAVE A RELATIVELY HIGH MOISTURE CONTENT AND APPEAR NORMALLY CONSOLIDATED. THIS IS INDICATED BY RELATIVELY LOW BLOW COUNTS ~~(FOUR TO TEN)~~ RECORDED FROM STANDARD PENETRATION TESTS PERFORMED IN BORINGS, BY LABORATORY ANALYSIS (E.G., ATTERBERG LIMITS) AND BY THE NATURAL MOISTURE CONTENTS BEING TYPICALLY NEAR THE LIQUID LIMIT OF SOILS. BASED ON THE ATTERBERG LIMIT EVALUATIONS CONDUCTED DURING THE PREVIOUS INVESTIGATIONS, THE LIQUID LIMIT OF THE GLACIOLACUSTRINE/TILL MATERIAL VARIES FROM ABOUT 30% TO 40% AND THE PLASTIC LIMIT IS ABOUT 20%. THE WATER CONTENT OF THE MATERIAL, WHILE VARIABLE, TENDS TO INCREASE LINEARLY WITH DEPTH FROM ABOUT 15% TO 25% (ABOUT THE PLASTIC LIMIT) NEAR THE TOP OF THE SURFICIAL DEPOSIT TO ABOUT 25% TO 35% (ABOUT THE LIQUID LIMIT) AT ABOUT AN ELEVATION OF 585 FT. ABOVE MEAN SEA LEVEL. SIMILARLY, THE STANDARD PENETRATION TEST RESISTANCE "N" VALUES IN THE SURFICIAL DEPOSIT DECREASE FROM ABOUT 10 TO 30 BLOWS/FT. NEAR THE TOP OF THE SURFICIAL DEPOSIT (STIFF TO VERY STIFF CONSISTENCY) TO ABOUT 3 TO 10 BLOWS/FT. AT ABOUT AN ELEVATION OF 585 FT. ABOVE MEAN SEA LEVEL (SOFT TO STIFF CONSISTENCY). THIS PATTERN OF DECREASING PENETRATION RESISTANCE AND INCREASING WATER CONTENT WITH DEPTH IS TYPICAL OF DESICCATION HARDENING ASSOCIATED WITH A GROUNDWATER TABLE AT ABOUT AN ELEVATION OF 580 FT ABOVE MEAN SEA LEVEL TO 590 FT. ABOVE MEAN SEA LEVEL DURING THE GEOLOGIC PAST.

GLACIAL TILL UNDERLIES THE LACUSTRINE SOILS AND GENERALLY CONSISTS OF AN UPPER UNIT, WHICH IS CONTINUOUS ACROSS THE FACILITY, AND A LOWER UNIT WHICH IS DISCONTINUOUS. THE UPPER UNIT, WHICH COMPRISES THE MAJORITY OF THE TILL DEPOSIT, IS FAIRLY WELL GRADED AND GENERALLY CONSISTS OF SILTY CLAY TO CLAYEY SILT WITH SOME SAND AND GRAVEL. IT IS RELATIVELY HOMOGENEOUS IN COMPOSITION AND EXHIBITS NO LAMINATION, BEDDING OR OTHER DISTINCT DEPOSITIONAL STRUCTURES. THE LOWER DISCONTINUOUS UNIT, A LODGEMENT TILL, IS SOMEWHAT COARSER THAN THE UPPER UNIT AND IS GENERALLY COMPRISED OF A SILT WITH SOME SAND, CLAY AND GRAVEL. THE UPPER TILL UNIT RANGES FROM ELEVEN FEET TO THIRTY-EIGHT FEET IN THICKNESS AND THE LOWER TILL UNIT DOES NOT EXCEED THIRTEEN FEET IN THICKNESS, WHEN PRESENT.

~~The overburden which exists on site consists of two type of glacial deposits. At the surface is a silty clay or clayey silt lacustrine deposit, approximately ten to twenty feet in thickness. The lacustrine material is underlain by a glacial till approximately thirty feet thick, which lies directly on top of the bedrock.~~ These two basic soil deposits, the lacustrine material and the glacial till, can be subdivided even further. Generalized geologic cross sections cutting across the facility are presented as Figure 4-4. These geologic cross sections are based on previous data collected during investigations conducted at the facility in the past. Figure 4-5 presents the well, boring and piezometer location map, with the location of the cross section lines. Most of the piezometer's and borings were plugged after data collection and the current monitoring system consists of 47 lacustrine (L), till (T) and bedrock monitoring (MW) wells.

The till unit actually consists of two separate tills: a thin (zero to ten feet thick) lowermost unit consisting of material derived from the bedrock; and a thick clay-rich upper unit. The lower till contains considerable amounts of sands and gravels, many of which are composed of soft weathered gypsum. This lowermost basal till is not found continuously across the site. It represents an early glaciation and apparently was partially eroded by a subsequent glacial readvance. The TOTAL thickness of the till deposits (UPPER AND LOWER) are presented on the Till Isopach Map in Figure 4-6.

The remaining upper till deposit consists of a silty clay with some sand and traces of gravel. ~~Permeabilities within this upper till deposit range from 1 x 10^{-8} to 1 x 10^{-9} cm/sec.~~ The material was derived from lacustrine silts and clays that were deposited in a proglacial lake during a previous retreat of the glacial ice. The upper surface of the silty clay till was probably undulating with a probable relief of five to twenty feet. The upper few feet of the till material, although texturally identical to the lower portion, appears to be slightly different structurally in that there is a suggestion of lacustrine lamination. This agrees with geological literature (Forsyth, 1965) that a water modified till is present in several places in northern Ohio, sandwiched between a till and overlying lacustrine material. The water modified till consists of till material that was deposited into or through water and, therefore, can contain some of the characteristics of a lacustrine deposit. Transport distances, however, would be very short, as shown by the lack of sorting.

ACCORDING TO THE GOLDER REPORT TITLED " CONTINUOUS OVERBURDEN SAMPLING RESULTS" DATED MAY 1985, OUT OF 99 SAMPLED BORINGS REPRESENTING OVER 3,600 FEET DRILLED INTO THE OVERBURDEN SOIL AT THE CWM VICKERY FACILITY, 2,000 FEET OF OVERBURDEN SOIL HAS BEEN RETRIEVED AS SAMPLES, CLOSELY INSPECTED, CLASSIFIED AND LOGGED. MATERIAL WHICH CAN BE CLASSIFIED AS PREDOMINANTLY SAND WAS ENCOUNTERED IN ONLY FOUR INTERVALS WITH A TOTAL OF 5.7 FEET. THESE SAND POCKETS WERE ONLY DETECTED WITH THE GLACIAL TILL SOILS. NONE OF THESE POCKETS WERE LOCATED IN THE AREA OF THE THIN TILL AREA WHICH COINCIDES WITH THICK LACUSTRINE DEPOSITS. THE RESULTS OF THE CONTINUOUS SAMPLING BORING PROGRAM CONDUCTED BY GOLDER AND DATA FROM THE PREVIOUS BORINGS AT THE SITE CLEARLY INDICATE AN ABSENCE OF CONTINUOUS OR LARGE POCKETS OF SAND OR OTHER GRANULAR MATERIAL WITHIN THE OVERBURDEN SOILS. THOSE FEW INSTANCES WHERE SUCH MATERIALS WERE ENCOUNTERED DURING SOIL SAMPLING PROGRAMS CONDUCTED AT THE FACILITY IN THE PAST APPEAR AS ISOLATED POCKETS NOT FOUND IN INTERVENING BOREHOLES. THE COARSER POCKETS CONSISTING PREDOMINANTLY OF SAND WITH LITTLE TO NO SILT OR CLAY FINES WERE FOUND WITHIN THE GLACIAL TILL WELL BELOW THE GROUND SURFACE AND THE BOTTOM OF ANY OF THE PREVIOUS SURFACE IMPOUNDMENTS OR THE TSCA CLOSURE CELL. SUCH ISOLATED POCKETS OF COARSE SOIL ARE NOT UNCOMMON IN GLACIAL TILL AND ARE NOT INDICATORS OF MAJOR, CONTINUOUS GRAINED LAYERS WITHIN THE TILL.

The lacustrine material overlying the till material can also be subdivided into two groups. Generally the lower five feet contains some fine sand and silt layers alternating with clay layers; however, even the fine sand and silt layers contain considerable amounts of clay. The thicknesses range from very thin up to one-half inch. A composite grain-size analysis of a sample from this unit indicates the unit has a composition of 3 percent sand, 55 percent silt, and 42 percent clay. The same sample also is documented as having a horizontal permeability of 8.6×10^{-8} cm/sec. Some of these layers are documented as being brown, rather than gray, indicating oxidation has occurred sometime during the postdepositional history of the unit.

This lower stratified portion of the lacustrine material is not found continuously across the facility. However, the lower portion of the lacustrine deposit is documented as appearing to be continuous across the active part of the facility where the ~~lagoons~~ SURFACE IMPOUNDMENTS were once located. It most probably represents a time period of shortly after deglaciation when the proglacial lake was first formed in front of the ice. The varve-like lamina may be caused by seasonal fluctuations in sediment input from the nearby melting ice, or may represent periodic but not seasonal influxes.

The remaining upper lacustrine material consists of an average of 49 percent clay, 46 percent silt, and 5 percent sand, and some of the samples collected across the site contained gravel. The material is very homogeneous with almost no indication of fine sand or silt layers present, although most samples collected are laminated along bedding planes. The thickness of the lacustrine deposits are presented as the Lacustrine Isopach Map in Figure 4-7.

~~Vertical permeabilities of the upper lacustrine material are on the order of 1 x 10^-8 to 1 x 10^-9 cm/sec. Horizontal permeabilities are expected to be similar because of the high clay content and the lack of well-sorted sand lamina. The single low horizontal permeability on material that is expected to have a higher permeability would also support this. The deposit was laid down in relatively quiet water some distance from the ice front. The small amounts of gravel present may have been rafted in on melting ice sheets.~~

ABOVE THE GLACIAL DEPOSITS ENCOUNTERED ON SITE IS A NON-CONTINUOUS LAYER OF FILL. THIS FILL LAYER WAS EXCAVATED IN THE MAIN BORROW AREA, LOCATED IN THE NORTHWEST CORNER OF THE SITE. THE MATERIAL FROM THE BORROW AREA WAS USED IN THE CONSTRUCTION OF THE CLOSURE CELL AND AS FILL MATERIAL DURING INTERIM REMEDIAL ACTIVITIES PERFORMED AT THE

SITE. THE FILL MATERIAL IS BASICALLY THE SAME LACUSTRINE MATERIAL FOUND AT THE SURFACE AND AS DESCRIBED BELOW.

4.3.3 Surface Soils

The surface soils on the site consist of the Del Ray and Lenawee series (Figure 4-8). Both soils formed in lacustrine deposits. The Lenawee series contains more clay than the Del Ray series, but otherwise they are very similar. Both contain stratified silts and clays in their lower portions.

4.4 HYDROGEOLOGY

4.4.1 Previous Investigations

The site hydrogeology has been thoroughly studied through previous investigations performed at the site. The first significant hydrogeologic investigation for the facility was conducted by Bowser-Morner (1983). This study produced information on the hydrogeology of the site and a statistical analysis of the groundwater quality data was performed. The majority of site-specific studies that followed the Bowser-Morner investigation were conducted by Golder Associates. These site-specific studies reevaluated the hydrogeologic system based upon additional data and focused on specific issues concerning the hydrogeologic or monitoring systems. A listing of site-specific hydrogeologic studies performed at the facility is included in the reference section .

4.4.2 Groundwater Flow in the Bedrock

Groundwater flow in the dolomite bedrock under the facility has been interpreted from water level data collected over several years. Bowser-Morner identified a radial flow pattern which is produced by pumping the on-site truck wash well.

The bedrock units are quick to respond to pumping stresses at the site. This is typical of a confined aquifer with fracture flow. Under non-pumping conditions these units quickly recover toward natural flow and gradient conditions. IN ORDER TO PRODUCE A POTENTIOMETRIC SURFACE MAP FOR THE BEDROCK AQUIFER THAT IS NOT BIASED BY THE PUMPING OF THE TRUCK WASH WELL, THE TRUCK WASH WELL IS TURNED OFF 24-HOURS PRIOR TO COLLECTING WATER LEVELS. Figure 4-9 is a potentiometric map made from water level elevations collected during the most recent sampling event (October 10, 1994). This potentiometric map represents a flat surface under the facility with a slight gradient to the northwest. A FURTHER CHARACTERIZATION OF THE FRACTURED AQUIFER SYSTEM UNDER THE SITE WAS COMPLETED BY GOLDER IN 1986 TO DETERMINE THE BEHAVIOR OF THE DOLOMITE BEDROCK AQUIFER SYSTEM SO ITS RESPONSES TO AQUIFER STRESSES COULD BE UNDERSTOOD. THE ADDITIONAL STUDY PROGRAM WAS DEVELOPED AND APPROVED BY THE FACILITY AND THE OEPA. THE PROGRAM CONSISTED OF THREE PRIMARY TASKS: INSTALLATION OF A PIEZOMETER TO THE NORTH OF THE OHIO TURNPIKE, THE INSTALLATION OF CONTINUOUS WATER LEVEL RECORDERS TO PROVIDE THE TECHNICAL BASIS FOR MAKING BAROMETRIC PRESSURE CORRECTIONS TO WATER LEVEL DATA, AND THE PERFORMANCE OF A A PUMPING TEST ON THE TRUCK WASH WELL AND MEASURING GROUNDWATER LEVEL CHANGES IN THE SITE BEDROCK MONITORING WELLS. THIS ADDITIONAL DATA WAS REVIEWED TO IDENTIFY AND EVALUATE EXTERNAL STRESSES AFFECTING GROUNDWATER LEVEL.

PHYSICAL AND/OR HYDRAULIC BARRIERS MAY EXIST AROUND THE EDGE OF THE FACILITY AND FLOW IN THE DOLOMITE AQUIFER IS CONTROLLED BY FRACTURE FLOW MECHANISMS. REVIEW OF TOP OF ROCK DATA INDICATES THAT A RIDGE ALONG THE SOUTHERN SIDE OF THE BOUNDARY MAY HELP CREATE THE FLAT GRADIENTS THAT EXIST UNDERNEATH THE FACILITY AND THE STEEPER GRADIENTS TO THE SOUTH. GENERALLY, THERE IS A STEPPED APPEARANCE IN THE SURFACE OF THE DOLOMITE. THIS MAY BE DUE TO SHEARING WITHIN THE DOLOMITE AND/OR GLACIAL ACTION HAVING SCOURED ZONES OF WEAKNESS TO PRODUCE THE PRESENT PHYSICAL APPEARANCE. THE EXISTENCE OF BOUNDARIES WITHIN THE AQUIFER WHICH ALTER THE AQUIFER DRAWDOWN PATH MAY OVERSHADOW THE ANISOTROPY OF THE SYSTEM.

A WATER LEVEL DATA AND BOUNDARY ANALYSIS COMPLETED BY GOLDER IN 1986 SUGGESTS THAT LARGE MAN-MADE SURFACE FEATURES, SUCH AS THE LARGE EMBANKMENTS BUILT AS CROSS-OVERS BY THE OHIO TURNPIKE OVER ROADS IN THE IMMEDIATE AREA, PLACE STRESSES ON THE AQUIFER SYSTEM. THESE STRESSES CAUSE SLIGHT FLOW IMPEDIMENTS, SUCH AS THE POSSIBILITY OF CLOSING FRACTURES AND FINE PARTINGS AND REDUCING THE HYDRAULIC CONDUCTIVITY WITH THE UPPER PORTION OF THE ROCK. IN ADDITION, GOLDER STATES IN THEIR 1986 REPORT THAT THE CONTINUED SURGE PUMPING DUE TO SITE

OPERATIONS IN ON-SITE WELLS HAVE PROBABLY HELPED TO HYDRAULICALLY DEVELOP THE AQUIFER SYSTEM WITHIN THESE BOUNDARIES.

THE BEDROCK AQUIFER SYSTEM AT THIS SITE EXHIBITS SOME ANISOTROPIC BEHAVIOR UNDER DIFFERENT PORTIONS OF THE FACILITY. ~~IS CONSIDERED TYPICAL FOR~~ AS EXPECTED FOR A FRACTURED DOLOMITE AQUIFER. EXAMINATION OF THE BOREHOLE LOGS FOR THE SITE BY GOLDER HAS ALLOWED A RE-INTERPRETATION OF THE DOLOMITE BEDROCK SURFACE. ~~THE BEDROCK CONTOUR MAP INDICATES A RIDGE NEAR THE SOUTHERN BOUNDARY OF THE SITE. GENERALLY, THERE IS A STEPPED APPEARANCE IN THE SURFACE OF THE DOLOMITE. THIS MAY BE DUE TO SHEARING WITHIN THE DOLOMITE AND/OR GLACIAL ACTION HAVING SCOURED ZONES OF WEAKNESS TO PRODUCE THE PRESENT PHYSICAL APPEARANCE. THE EXISTENCE OF BOUNDARIES WITHIN THE AQUIFER WHICH ALTER THE AQUIFER DRAWDOWN PATH MAY OVERSHADOW THE ANISOTROPY OF THE SYSTEM. THESE DRAWDOWN BOUNDARIES MAY BE THE RESULT OF CURRENT AND PAST LOADINGS, SUCH AS GLACIATION. CYCLIC PUMPING WITHIN THE SITE AREA (TRUCK WASH WELL) MAY MAGNIFY THE PERMEABILITY CONTRASTS.~~ THE EXACT LOCATIONS OF THE BOUNDARIES ARE NOT SIGNIFICANT IN DETERMINING FLOW DIRECTIONS FROM WATER LEVEL DATA. HOWEVER, THE BOUNDARY EFFECTS AND PERMEABILITY CONTRASTS DO CAUSE HIGHER WATER LEVELS AND GRADIENTS AT THE PERIPHERY OF THE FACILITY. THE DISCONTINUOUS FRACTURE SYSTEM CAUSES DIFFERENTIAL DRAWDOWNS AT SITE WELLS DURING PUMPING FROM WELLS, SO WELLS LESS THAN 50 FEET APART OFTEN HAVE DIFFERENT WATER LEVELS. THESE NON-UNIFORM RESPONSES ARE TYPICAL OF RANDOMLY FRACTURED ROCK SYSTEMS.

~~The overall water level elevation data from shallow monitoring wells completed within the overburden materials indicate a trend of decreasing potential to the northwest, which is generally the direction of ground surface slope. The potential levels shown in the till are lower than the potential levels in the lacustrine deposits, indicating a downward vertical gradient toward the dolomite aquifer. Figures 4-10 and 4-11 present the most recent phreatic and potentiometric contour surface maps for the lacustrine and till monitoring wells.~~

~~Based on a review by Golder Associates using collected data and experience with similar geologic materials, the hydraulic conductivity representative of the dolomite aquifer underlying the site is~~

~~6 x 10^{-3} cm/sec or 125 gallons/day/ft^2. The mean hydraulic conductivity of the lacustrine soils is 6 x 10^{-6} cm/sec, while that of the glacial till is 2.4 x 10^{-7} cm/sec. The glacial overburden, therefore, acts as a confining layer (aquitard) at the facility.~~ ACCORDING TO THE GOLDER REPORT TITLED " SUMMARY AND CHARACTERIZATION OF SITE HYDROGEOLOGIC CONDITIONS, SEPTEMBER 1983, THE MOST REPRESENTATIVE HYDRAULIC CONDUCTIVITY OF THE DOLOMITE BEDROCK UNDER THE SITE IS 1 X 10^{-2} CM/SEC OR 210 GPD/FT^2. THIS REPRESENTATIVE VALUE HAS BEEN ESTIMATED BY GOLDER USING SEVERAL METHODS INCLUDING ; LARGE SCALE PUMPING TESTS CONDUCTED BY THE OHIO DEPARTMENT OF NATURAL RESOURCES IN THREE WELLS COMPLETED IN THE AQUIFER AT LOCATIONS APPROXIMATELY 3 TO 10 MILES FROM THE SITE; A SMALL SCALE PUMPING TEST AT THE SITE CONDUCTED BY BOWSER-MORNER IN 1983; PRESSURE PACKER TESTS BY GOLDER IN THREE BOREHOLES ON SITE, THE RESULTS OF DRAWDOWN (SPECIFIC CAPACITY) TESTS PERFORMED BY DAMES & MOORE IN THE SITE MONITORING WELLS DURING WATER QUALITY SAMPLING; AND CALCULATION OF HYDRAULIC PROPERTIES FROM EMPIRICAL RELATIONSHIPS.

The major recharge for the dolomite aquifer in this area occurs roughly 3 miles to the southeast of the facility, where the bedrock surface rises to within several feet of the ground surface. PRESSURES WITHIN THE BEDROCK AQUIFER ALLOW THE HEAD TO RISE APPROXIMATELY 25 FEET ABOVE THE TOP OF BEDROCK SURFACE CAUSING ARTESIAN CONDITIONS TO EXIST IN THE BEDROCK UNDERLYING THE AQUIFER SITE.

4.4.3 Groundwater Flow in the Surficial Deposits

The potentiometric surface in the lacustrine soils is higher than the potentiometric surface of the glacial till, which is higher than the potentiometric surface of the dolomite aquifer. The decreasing pressure with depth causes a downward vertical gradient toward the dolomite. However, the amount of flow through the overburden at the site is likely to be inconsequential, due to its low permeability, in relation to the amount of recharge to the aquifer from off-site.

VERTICAL PERMEABILITIES OF THE UPPER LACUSTRINE MATERIAL ARE ON THE ORDER OF 10^{-8} TO 10^{-9} CM/SEC, AS DETERMINED BY BOWSER-MORNER USING SIX

LABORATORY TESTS. HORIZONTAL PERMEABILITIES ARE EXPECTED TO BE SIMILAR BECAUSE OF THE HIGH CLAY CONTENT AND THE LACK OF WELL-SORTED SAND LAMINA. A SINGLE TEST CONDUCTED IN THE HORIZONTAL DIRECTION BY GOLDER YIELDED A HYDRAULIC CONDUCTIVITY ON THE ORDER OF 10^{-8} CM/SEC. THE RESULTS OF IN-SITU RISING HEAD TESTS CONDUCTED BY GOLDER IN PIEZOMETERS INSTALLED IN THE LACUSTRINE DEPOSIT INDICATED THAT THE HYDRAULIC CONDUCTIVITY MAY BE ON THE ORDER OF 10^{-6} CM/SEC. THE GREATER HYDRAULIC CONDUCTIVITY MEASURED IN-SITU MAY ARISE FROM TWO FACTORS: 1) THE IN-SITU MEASUREMENTS ARE LIKELY DOMINATED BY HYDRAULIC CONDUCTIVITY IN THE HORIZONTAL DIRECTION, WHICH IS EXPECTED TO BE GREATER THAT IN THE VERTICAL DIRECTION DUE TO THE LAYERED NATURE OF THE SOIL AND THE PRESENCE OF SANDY PARTINGS; AND 2) THE PRESENCE OF OPEN FRACTURES IN THE DESICCATED CRUST OF THE SOIL. ALTHOUGH FRACTURES WERE NOT DIRECTLY OBSERVED IN SAMPLES OF THE LACUSTRINE MATERIALS BY GOLDER, THEIR EXPERIENCE WITH SIMILAR SOILS SUGGESTED THAT A FRACTURE "POROSITY" MAY TYPICALLY BE ON THE ORDER OF 0.001. HOWEVER, TO DATE NO FRACTURES HAVE BEEN NOTED DURING THE DRILLING OF SOIL BORINGS AND THE LACUSTRINE CLAY HAS BEEN FOUND TO BE CONTINUOUS ACROSS THE SITE. THEREFORE GOLDER'S ESTIMATE SHOULD BE USED AS A CONSERVATIVE ESTIMATE FOR THE PURPOSE OF CALCULATING GROUNDWATER FLOW.

~~ON THE BASIS OF~~ THE LABORATORY TESTS AND FIELD TESTS CONDUCTED BY GOLDER AND BOWSER-MORNER, IT IS ESTIMATED THAT THE HYDRAULIC CONDUCTIVITY OF THE LACUSTRINE SOILS IS ABOUT 1 X 10^{-6} CM/SEC IN THE FRACTURED OR DESICATED ZONE. BENEATH THIS ZONE, IT IS ESTIMATED THAT THE HYDRAULIC CONDUCTIVITY IN THE VERTICAL DIRECTION IS ABOUT 2 X 10^{-8} CM/SEC, AND IN THE HORIZONTAL DIRECTION, ABOUT 1 X 10^{-7} CM/SEC. A HYDRAULIC CONDUCTIVITY OF 1 X 10^{-6} CM/SEC (1 FT/YR) IS USED AS A CONSERVATIVE ESTIMATE TO DEVELOP THE FLOW VELOCITIES ON THE GROUNDWATER CONTOUR MAP (FIGURE 4-11). THE RESULTS OF THE LABORATORY TESTING OF THE GLACIAL TILL SOIL BY BOWSER-MORNER INDICATED THAT THE HYDRAULIC CONDUCTIVITY RANGES FROM ABOUT 3 X 10^{-8} CM/SEC TO 6 X 10^{-9} CM/SEC. THE IN-SITU RISING HEAD TESTS CONDUCTED BY GOLDER WERE DETERMINED TO BE IN CLOSE AGREEMENT, INDICATING THAT

THE HYDRAULIC CONDUCTIVITY IS ABOUT 2 X 10^{-8} CM/SEC. THE CLOSE AGREEMENT BETWEEN LABORATORY AND IN-SITU TESTS SUGGESTS THE UNIFORMITY IN COMPOSITION AND THE LACK OF STRUCTURE IN THE SOIL.

THE GRADIENT IN THE GLACIAL OVERBURDEN WAS OBSERVED BY GOLDER TO BE PRIMARILY DOWNWARD. Average vertical flow times, as calculated by Golder Associates, have been estimated to be on the order of 100 years from lacustrine soils to bedrock. A SMALL COMPONENT OF FLOW IN THE LACUSTRINE MATERIALS WAS DIRECTED LATERALLY TOWARDS THE DRAINAGE DITCHES, DURING THE OPERATION OF THE SURFACE IMPOUNDMENTS. THIS LATERAL FLOW TOWARDS THE DRAINAGE DITCHES HAS SINCE BEEN MINIMIZED BY THE INTERIM CORRECTIVE MEASURE ACTIVITIES COMPLETED AT THE SITE (SECTION 6.0). THE CAPILLARY DRAIN CONSTRUCTED UNDERNEATH THE TSCA CLOSURE CELL (SECTION 6.2) IS A TWO FOOT LAYER OF COARSE STONE. THIS LAYER OF COARSE STONE ALLOWS FOR THE DRAINING OF THE GLACIAL OVERBURDEN IN THE CENTRAL PORTION OF THE SITE, AS IT WAS DESIGNED, AND ACTS AS A DISCHARGE ZONE. THIS IS INDICATED BY THE GROUNDWATER ELEVATION CONTOURS IN THE CENTRAL PORTION OF THE SITE IN BOTH THE LACUSTRINE AND TILL ZONES. THERE IS A POTENTIAL FOR DISCHARGE OF GROUNDWATER TO THE DITCHING SYSTEM. THE BOTTOM ELEVATION OF THE ON-SITE DITCHING SYSTEM IN COMPARISON TO THE GROUNDWATER ELEVATIONS IN THE LACUSTRINE GROUNDWATER WATER WELLS, DO ALLOW FOR THE DISCHARGING OF THE GROUNDWATER INTO THE ON-SITE SURFACE DITCHES. HOWEVER, THIS IS UNLIKELY DUE TO THE PERMEABILTIES OF THE LACUSTRINE SOILS. ON-SITE PERSONNEL HAVE DOCUMENTED THAT THE ON-SITE DITCHES CONTAIN WATER DURING RAIN EVENTS OR EXTENDED PERIODS OF RAINFALL. THE SURFACE WATER WHICH REMAINS WITHIN THE DITCHES EITHER RUNS OFF INTO THE CONNECTING STREAMS OR EVAPORATES. SEASONAL FLUCTUATIONS OF THE GROUNDWATER LEVELS ON SITE HAVE BEEN DETERMINED TO A LESSER EXTENT. ONLY MONITORING WELLS WHICH ARE PART OF THE QUARTERLY SAMPLING EVENTS ARE MONITORED. THESE WELLS DO NOT REPRESENT THE ENTIRE FACILITY, AS IN THE SEMI-ANNUAL SAMPLING EVENT. HOWEVER BASED ON LIMITED INFORMATION IT SEEMS THAT GROUNDWATER LEVELS WITHIN THE BEDROCK AQUIFER VARY VERY LITTLE FROM SEASON TO SEASON, EXHIBITING USUALLY LESS THAN ½ FOOT OF CHANGE. THE LACUSTRINE AND TILL ZONES GROUNDWATER LEVELS SEEM TO VARY UP TO TWO FEET OR

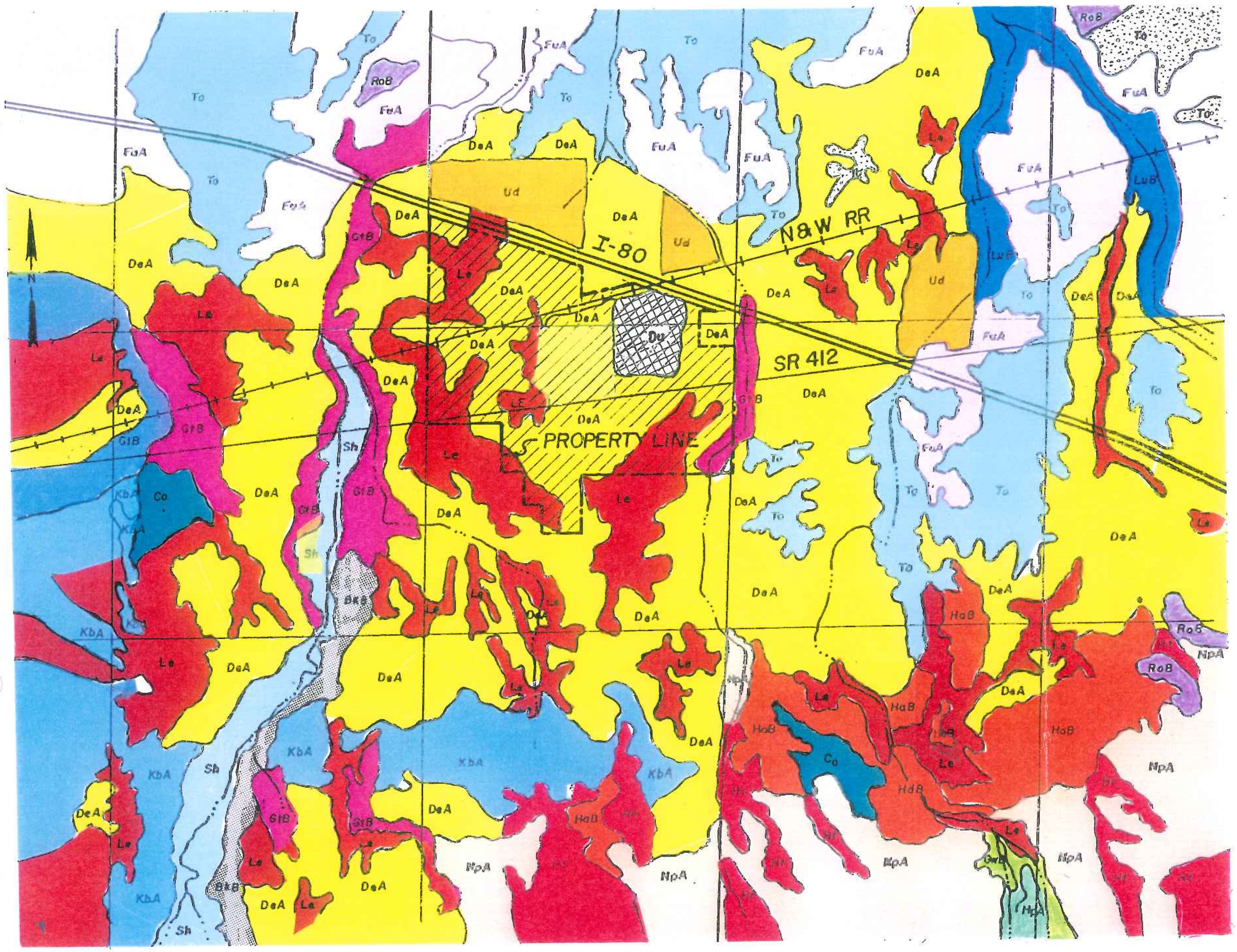
MORE, DEPENDING ON PRECIPITATION AMOUNTS DURING THE SEASON. A COMPLETE COLLECTION OF GROUNDWATER MEASUREMENTS ON ALL OF THE FACILITY GROUNDWATER MONITORING WELLS HAS NOT BE CONDUCTED FOR EACH OF THE SEASONS.

THE OVERALL WATER LEVEL ELEVATION DATA FROM SHALLOW MONITORING WELLS COMPLETED WITHIN THE OVERBURDEN MATERIALS INDICATE A TREND OF DECREASING POTENTIAL TO THE NORTHWEST, WHICH IS GENERALLY THE DIRECTION OF GROUND SURFACE SLOPE. THE POTENTIAL LEVELS SHOWN IN THE TILL ARE LOWER THAN THE POTENTIAL LEVELS IN THE LACUSTRINE DEPOSITS, INDICATING A DOWNWARD VERTICAL GRADIENT TOWARD THE DOLOMITE AQUIFER. FIGURES 4-10 AND 4-11 PRESENT THE MOST RECENT PHREATIC AND POTENTIOMETRIC CONTOUR SURFACE MAPS FOR THE LACUSTRINE AND TILL MONITORING WELLS. FIGURES 4-12 THROUGH 4-17 PRESENT PREVIOUS GROUNDWATER CONTOURS FOR EACH OF THE MONITORED INTERVALS. FIGURE 18 THROUGH FIGURE 23 PRESENT GROUNDWATER CONTOURS FOR JANUARY 1993 AND JULY 1993.

AS INDICATED IN FIGURE 4-11, THE CONTOUR LINES WHICH ARE GREY SCALED REPRESENT THE CONTOURS PREVIOUSLY REPORTED. THE UPDATED GROUNDWATER CONTOURS ARE BASED ON THE FACT THAT MONITORING WELLS L31 AND L33 WERE DRY DURING OCTOBER 10, 1994 WATER LEVEL MEASUREMENTS. THESE TWO WELLS ARE IN THE RECORD AS NOT BEING GOOD PRODUCERS OF WATER AND IN MOST CASES, RECHARGE TO THESE MONITORING WELLS DURING SAMPLING EVENTS CAN TAKE ~~UP TO~~ GREATER THAN THREE FULL DAYS. ADDITIONALLY, THE CALENDAR YEAR 1994 WAS VERY DRY AND THE PHREATIC SURFACE OF THE LACUSTRINE SOILS WAS MUCH LOWER THAN THAT OF AN AVERAGE YEAR. THE CWM-VICKERY FACILITY IS NOW SAMPLING THESE MONITORING WELLS ON A QUARTERLY BASIS, AS REQUIRED BY TSCA, AND THESE MONITORING WELLS ARE REPORTED TO BE DRY, OR VERY CLOSE TO DRY AT EACH OF THESE QUARTERLY SAMPLING EVENTS. THE WATER ELEVATIONS PROVIDED DURING THE GENERATION OF THE CONTOURS WERE BASED ON A WATER LEVEL WHICH IS BELIEVED TO BE AT THE BOTTOM OF THE MONITORING WELL, AND NOT ACTUAL RECORDED GROUNDWATER ELEVATIONS. ~~TAKING ALL OF THE SITUATIONS EXPLAINED ABOVE, INTO ACCOUNT, AS PRESENTED ON~~

~~FIGURE 4-11, THE VALLEY OR TROUGH, PREVIOUSLY REPORTED, DOES NOT OCCUR AND THE GROUNDWATER SURFACE RESPONDS AS EXPECTED.~~ ADDITIONALLY, THE MONITORING WELLS MAY BE INSTALLED WITHIN LOWER PERMEABILITY ZONES WITHIN THE LACUSTRINE SOILS. LOWER PERMEABILE MATERIAL WOULD CAUSE GREATER FLUCTUATION WITHIN THE GROUNDWATER LEVELS WHEN SAMPLING IS CONDUCTED. IT CAN TAKE UP TO NINE MONTHS OR GREATER FOR FULL RECOVERY OF WELLS IN SIMILAR MATERIAL, IF SAMPLING IS NOT CONDUCTED. THEREFORE, INSTEAD OF THE EXISTENCE OF A GROUNDWATER VALLEY OR TROUGH IN THIS AREA OF THE FACILITY, THE EXPLANATION FOR LOWER GROUNDWATER ELEVATIONS COULD BE THE PRESENCE OF LOWER PERMEABLE MATERIAL COMBINED WITH VERY SLOW RECHARGE TO THESE GROUNDWATER WELLS. ALL OF THE ABOVE SCENARIOS CAN OCCUR TO PRODUCE THE GROUNDWATER TROUGH OR VALLEY.

FIGURES



SOIL DESCRIPTION (USDA UNPUBLISHED)

Bkb — BIXLER LOAMY FINE SAND — 2 - 6% SLOPES
THE BIXLER SERIES CONSISTS OF DEEP, SOMEWHAT POORLY DRAINED TWO-STORY SOILS DEVELOPED ON OUTWASH PLAINS, BEACH RIDGES AND DELTAS. BIXLER SOILS FORMED IN SANDY AND LOAMY MATERIAL 20 TO 35 INCHES THICK OVER STRATIFIED LACUSTRINE SILTY LOAM. PERMEABILITY IS RAPID IN THE SANDY MATERIAL AND MODERATE IN THE LOWER PART.

Co — COLWOOD FINE SANDY LOAM
THE COLWOOD SERIES CONSISTS OF DEEP, VERY POORLY DRAINED SOILS FORMED IN STRATIFIED LOAMY AND SANDY MATERIAL IN AREAS OF FORMER LAKE BEDS. PERMEABILITY IS MODERATE.

DeA — DEL RAY SILT LOAM — 0 - 2% SLOPES
THE DEL RAY SERIES CONSISTS OF DEEP, SOMEWHAT POORLY DRAINED SOILS ON OUTWASH PLAINS AND DELTAS IN AREAS OF FORMER LAKE BEDS. DEL RAY SOILS FORMED IN SILTY CLAY LOAM AND SILTY CLAY LACUSTRINE MATERIAL UNDERLAIN BY STRATIFIED SILT LOAM AND SILTY CLAY LOAM AT A DEPTH OF 34 TO 60 INCHES. PERMEABILITY IS SLOW. THE DEL RAY SERIES IS DISTINGUISHED FROM THE LENAWEE SERIES BY A LIGHTER SURFACE LAYER AND A LESSER AMOUNT OF CLAY.

FuA — FULTON SILTY CLAY LOAM — 0 - 2% SLOPES
THE FULTON SERIES CONSISTS OF DEEP SOMEWHAT POORLY DRAINED SOILS THAT FORMED IN CLAYEY LAKE-LAID SEDIMENT ON LAKE PLAINS AND DELTAS. PERMEABILITY IS VERY SLOW.

GlB — GLENFORD SILT LOAM — 2 - 6% SLOPES
THE GLENFORD SERIES CONSISTS OF MODERATELY WELL DRAINED SOILS ON LAKE PLAINS, TERRACES, AND OUTWASH PLAINS. GLENFORD SOILS FORMED IN SILTY LOAM AND SILT CLAY LOAM LACUSTRINE MATERIAL. PERMEABILITY IS MODERATELY SLOW.

GwB — GLYNWOOD SILT LOAM — 2 - 6% SLOPES
THE GLYNWOOD SERIES CONSISTS OF MODERATELY WELL DRAINED SOILS ON TILL AREAS OF LAKE PLAINS. GLYNWOOD SOILS FORMED IN SILT AND SILTY CLAY LOAMS. IN SOME AREAS THE SUBSOIL CONTAINS MORE SAND AND GRAVEL AND IS BETTER DRAINED. PERMEABILITY IS SLOW.

HaB — HASKINS SILT LOAM
THE HASKINS SERIES CONSISTS OF DEEP, SOMEWHAT POORLY DRAINED TWO-STORY SOILS ON OUTWASH PLAINS, TERRACES, AND BEACH RIDGES. HASKINS SOILS FORMED IN LOAMY MATERIAL 20 TO 40 INCHES THICK OVER FINE-TEXTURED TILL OR LACUSTRINE MATERIAL. PERMEABILITY IS MODERATE IN THE LOAMY MATERIAL AND SLOW OR VERY SLOW IN THE UNDERLYING MATERIAL.

Ht — HOYTVILLE SILTY CLAY LOAM
THE HOYTVILLE SERIES CONSISTS OF DEEP, VERY POORLY DRAINED SOILS ON TILL PLAINS IN AREAS OF FORMER LAKE BEDS. THE UPPER PORTION OF THE SOIL HAS BEEN MODIFIED BY WATER ACTION.

KbA — KIBBE FINE SANDY LOAM — 0 - 2% SLOPES
THE KIBBE SERIES CONSISTS OF SOMEWHAT POORLY DRAINED SOILS THAT FORMED IN LAKE-LAID SILT AND FINE SAND. THE SOIL BECOMES STRATIFIED AT A DEPTH OF 40 TO 60 INCHES. PERMEABILITY IS MODERATE.

Le — LENAWEE SILTY CLAY LOAM
THE LENAWEE SERIES CONSISTS OF DEEP, VERY POORLY DRAINED SOILS ON OUTWASH PLAINS AND DELTAS. LENAWEE SOILS FORMED IN SILTY CLAY AND SILTY CLAY LOAM MATERIAL UNDERLAIN BY STRATIFIED SILT LOAM AND SILTY CLAY LOAM AT A DEPTH OF 40 TO 60 INCHES. PERMEABILITY IS MODERATELY SLOW. THE LENAWEE SERIES IS DISTINGUISHED FROM THE DEL RAY SERIES BY A DARKER SURFACE LAYER AND A GREATER AMOUNT OF CLAY.

LuB — LUCAS SILTY CLAY — 2 - 6% SLOPES
THE LUCAS SERIES CONSISTS OF DEEP, WELL OR MODERATELY DRAINED SOILS ON LAKE PLAINS. LUCAS SOILS FORMED IN SILTY CLAY AND SILTY CLAY LOAM. PERMEABILITY IS SLOW OR VERY SLOW.

NpA — NAPPANEE SILT LOAM
THE NAPPANEE SERIES CONSISTS OF DEEP, SOMEWHAT POORLY DRAINED SOILS ON TILL PLAINS IN AREAS OF FORMER LAKE BEDS. NAPPANEE SOILS FORMED IN CALCAREOUS GLACIAL TILL WHOSE UPPER PART WAS MODIFIED BY WATER ACTION. PERMEABILITY IS VERY SLOW.

Sh — SHOALS SILT LOAM, OCCASIONALLY FLOODED
THE SHOALS SERIES CONSISTS OF DEEP, SOMEWHAT POORLY DRAINED SOILS THAT FORMED IN LOAMY ALLUVIUM ON FLOOD PLAINS. PERMEABILITY IS MODERATE.

To — TOLEDO SILTY CLAY — 0 - 2% SLOPES
THE TOLEDO SERIES CONSISTS OF DEEP, VERY POORLY DRAINED SOILS THAT FORMED IN CLAYEY LAKE-LAID SEDIMENT ON LAKE PLAINS AND DELTAS. PERMEABILITY IS SLOW.

Du — DUMPS OR LANDFILLS

REV.	DATE		DRN BY	APP BY

DATE: DECEMBER, 1994
DES BY
DRN BY JAT
CHK BY RZ
REV BY
APP BY

PROJECT NO. 38627 — SCALE: NOT TO SCALE
PROJECT: RCRA FACILITY INVESTIGATION
SHEET TITLE: SOILS MAP

RUST ENVIRONMENT & INFRASTRUCTURE

CWM-Vickery
Vickery, Ohio

SHEET ____ OF ____
DRAWING NO.
FIGURE 4-8